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A Study of Ozone Concentrations in Southern Louisiana

Radian Corp, Austin, TX

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A STUDY OF OZONE CONCENTRATIONS IN SOUTHERN LOUISIANA

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Contract No. 68-02-1383, Task Order 18

FINAL REPORT

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16. ABSTRACT

This report describes an air quality and meteorological monitoring program conducted at nine sites in southern Louisiana from July through October 1976. The objective of this monitoring program was to provide air quality data applicable to non-urban portions of southern Louisiana and to perform a limited analysis of the data gathered. It was found that the frequency of observations exceeding the 80 ppb standard for ozone at the nine sites ranged from four to seventeen percent of available observation with ten percent of the total number of observations exceeding a concentration of 80 ppb. Five percent of the total ozone observations exceeded a concentration of 100 ppb. The diurnal oxidant pattern at each of the sites is similar to patterns typically found in urban areas. It was not possible to ascertain the cause of the high ozone measurements, but examination of upper air trajectories for periods of high ozone concentrations shows that local urban sources are important contributors. Overall the NO_2 and SO_2 levels at all of the monitoring sites was very low. No concentrations of these pollutants in excess of air quality standard values were observed.

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a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Photochemical Oxidants	Ozone		
Sulfur Dioxide	Nitric Oxide		
Nitrogen Dioxide	Nitrogen Oxides		
Particulates	Wind Speed		
Wind Direction	Ambient Temperature		
Relative Humidity	Air Quality		
Air Quality Instrumentation	Meteorological Monitoring		

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EXECUTIVE SUMMARY

An air quality and meteorological monitoring program was conducted at nine sites in southern Louisiana from July through October 1976. The objective of this monitoring program was to provide air quality data applicable to non-urban portions of southern Louisiana and to perform a limited analysis of the data gathered.

Parameters monitored included ozone, sulfur dioxide, nitric oxide, nitrogen dioxide, nitrogen oxides, particulates, wind speed, wind direction, temperature, relative humidity, solar radiation (at three locations), and rainfall (at three locations). In addition to Radian's own meteorological monitoring, surface and upper air data were collected from over thirty other meteorological stations in the area.

The monitoring phase included an intensive quality assurance program of calibration audits and zero/span checks and the use of this quality assurance information to validate the data obtained.

The major results of the study are:

- The frequency of observations exceeding the 80 ppb standard for ozone at the nine sites ranged from four to seventeen percent of available observations with ten percent of the total number of observations exceeding a concentration of 80 ppb. Five percent of the total ozone observations exceeded a concentration of 100 ppb.

- For each of the nine sites, the second highest ozone concentration during the three-month study period is roughly twice the 80 ppb standard level.

- The diurnal oxidant pattern at each of the sites is similar to patterns typically found in urban areas. There were few isolated ozone events, i.e., most sites recorded either high or low ozone levels on the same days.

- It is difficult to ascertain the cause of the high ozone measurements, but examination of upper air trajectories for periods of high ozone concentrations shows that local urban sources are important contributors.

- Overall the NO_2 and SO_2 levels at all of the monitoring sites are very low. No concentrations of these pollutants in excess of air quality standard values were observed.

- NO_2 and SO_2 levels demonstrate a noticeable dependence on wind direction. NO_2 levels increase when the wind is blowing from urban centers. One site reported SO_2 values indicating the likelihood of an industrial source, or more likely two sources in the vicinity.

1.0 INTRODUCTION

The objective of this program was to provide three months of air quality and meteorological monitoring in southern Louisiana and to accomplish a limited analysis of the data gathered. This study was conducted under Basic Ordering Agreement 68-02-1383.

Parameters that were monitored included ozone, sulfur dioxide, nitric oxide, nitrogen oxides, particulates, wind speed, wind direction, temperature, relative humidity, solar radiation (three locations), and rainfall (three locations). Nine monitoring stations were dispersed over the southern portion of Louisiana. In addition to Radian's own meteorological monitoring, surface and upper air data were collected from over thirty other meteorological stations in the area. The monitoring phase included an intensive quality assurance program of calibrations, audits and zero/span checks, and the use of the quality assurance information to validate the data obtained.

The nine monitoring stations were located across the breadth of southern Louisiana as shown in Figure 1-1. A description of each site is contained in Appendix A.

This report is a summary of the results of the efforts undertaken on this project. Detailed data summaries and system documentation are not included in this report because of the volume of data collected. The data was submitted in an interim report and on magnetic tape to EPA Region VI and has been entered into the National Aerometric Data Bank. The bibliography lists three reports[2,3,4] that are a part of the project and a quality assurance report[1] that, while not a part of this project, was conducted as a separate study initiated as a result of findings during the course of this project.

Figure 1-1. Monitoring Trailer Locations in Southern Louisiana

2.0 INSTRUMENT SYSTEMS

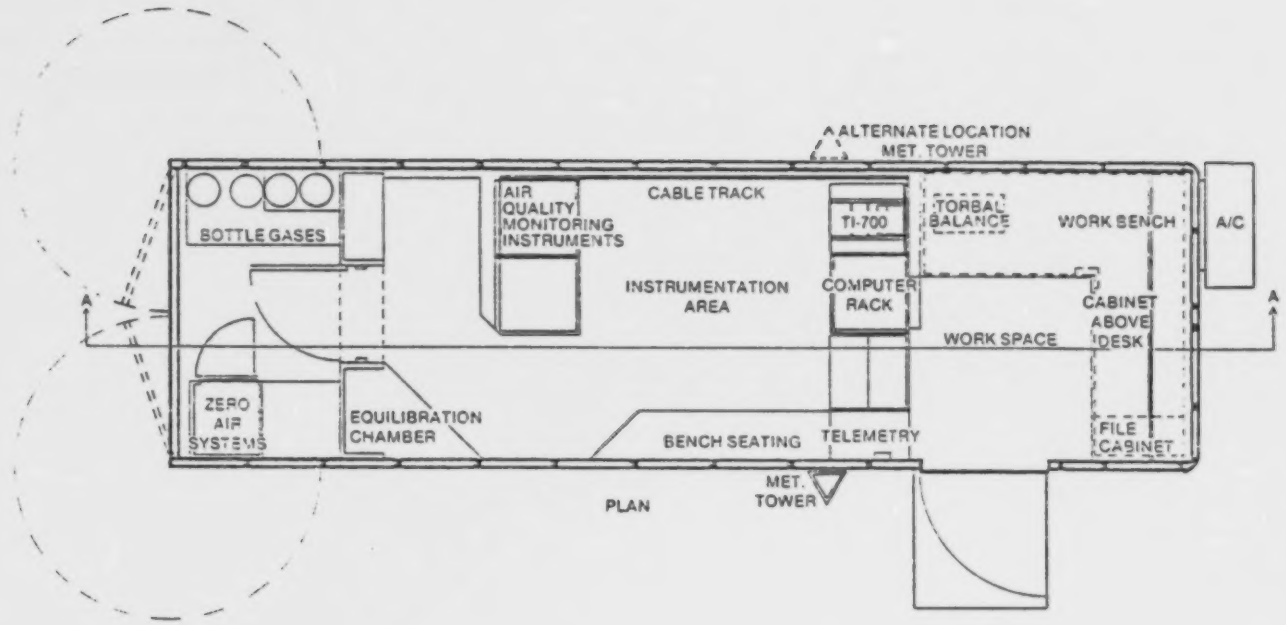
This section discusses the major components of the nine monitoring stations. Each system consisted of air quality instrumentation, meteorological instrumentation, and a computer-controlled data system housed in a twenty-six foot, fifth-wheel trailer. Figure 2-1 shows a typical configuration of the monitoring station. This station maintains a stable environment (±5°F) for the correct operation of all instruments.

2.1 Air Quality Instrumentation

The Meloy Laboratories Model OA350-2R Ozone Analyzer was used to measure ozone. This instrument continuously measures ozone by the chemiluminescent principle and is EPA-approved as an equivalent method for ozone. The instrument was operated on the approved range of 0-500 ppb.

The Meloy Laboratories Model NA520 Oxides of Nitrogen Analyzer was used to measure NO and NO_x. This instrument uses the chemiluminescent principle of analysis and has dual channels to continuously monitor the NO and NO_x. NO_2 is obtained by subtraction in the data system. The Model NA520 was operated on a 0-500 ppb range. The Model NA520 is not EPA-approved as an equivalent method for NO_2 measurement.

Sulfur dioxide was monitored with Meloy Model SA185-2 analyzers. These instruments are continuous analyzers using flame photometric detectors. Each analyzer was equipped with an ambient temperature hydrogen sulfide scrubber like that used on the Meloy Model SA-185-2A analyzer, which is EPA-approved as an equivalent method for SO_2.



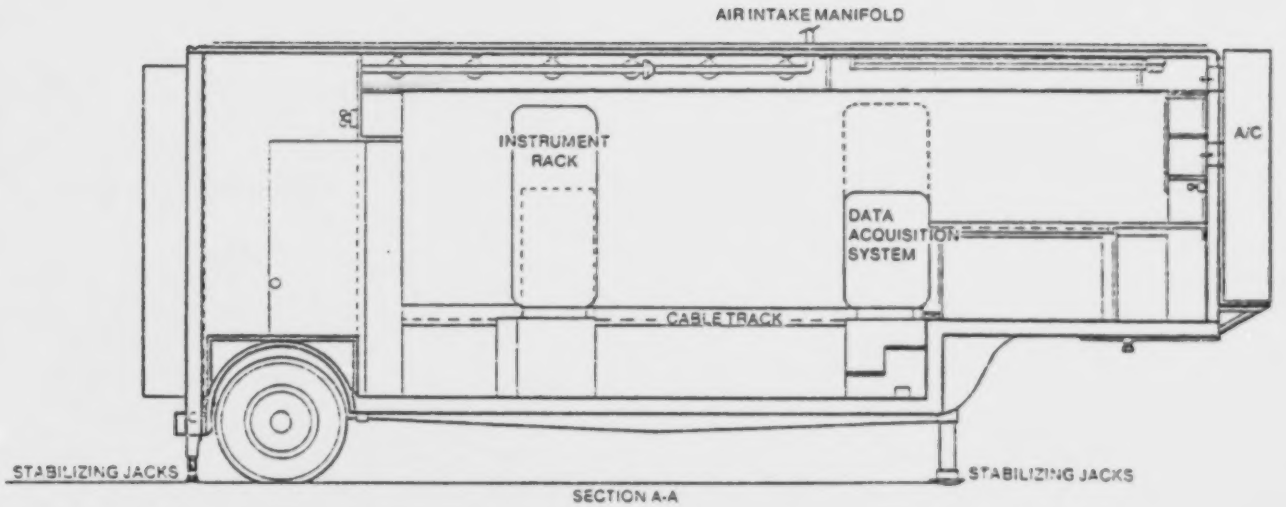


Figure 2-1. Typical Configuration of Monitoring Station

Particulates were measured on a daily basis. Each monitoring station was equipped with three High Volume samplers constructed according to Federal Register guidelines. The Hi-Vols ran for 24-hour periods (midnight to midnight) and were turned on and off by the station computer.

The air sample was drawn in through a glass cane and manifold supplied by the Ace Glass Company. The system had a 25 mm diameter, and a constant air flow through the system was provided by an air pump rated at 60 cfm at 0" head pressure. The manifold had sampling ports to which ½" teflon lines to the instruments were connected. All joints in the sampling system were secured by O-ring compression fittings. The manifold was contained in a heated (100°F) chamber to prevent condensation of moisture.

A Meloy Laboratories Model CNS1 calibrator was used for daily automatic zero/span checks on the SO_2 and NO_x analyzers. This unit provides a clean air source, an SO_2 span gas source from a permeation tube, and a dilution system for diluting bottled NO span gas. The ozone analyzer was equipped with an internal span source for automatic daily checks. A Meloy Model CNOS 40 dynamic calibrator was used for multi-point calibrations of all three parameters. A Bendix Model 8861D Transportable Field Calibration System, a Meloy Model CS10 calibrator, and a separate Meloy Model CN0540 calibrator were used for audits on the nine stations. The Hi-Vol samplers were calibrated using General Metal Works calibration kit that had been verified by a Roots meter.

2.2 Meteorological Instrumentation

The monitoring trailers were equipped with the following meteorological instrumentation: wind speed and direction, outside temperature, and relative humidity. The wind instrumentation was made by the Weather Measure Corporation. The anemometer was the Model W103/3L Cup Anemometer, a high response, low threshold wind system. The wind vane was a Model W104 Lightweight Vane by Weather Measure. This vane assembled operated in a 0° to 360° output range. The outside temperature was measured by a T621-T18 Standard Thermistor Probe. This probe, with a linearity of ±0.15°C, was shielded from solar radiation by means of a Model TT-102 Radiation Shield, made by Texas Electronics, which allows for natural aspiration of the probe. The relative humidity sensors were Texas Electronics Model 2013. All meteorological instrumentation was mounted atop a retractable 33-foot (10 meter) meteorological tower, the Model WM-33 Guyed Tower by Weather Measure.

Three stations were also equipped to measure rainfall and solar radiation. MRI heated rain/snow gages were used to measure precipitation. These instruments employ a tipping bucket sensor. Solar radiation was measured with an Eppley Precision Spectral Pyranometer.

2.3 Data Acquisition System

The station was equipped with its own data acquisition system consisting of five major components.

1) Analog-to-digital (A/D) System,
2) Data General NOVA 1200 Based Computer Unit and Memory,
3) Texas Instruments KSR-733 Keyboard/Printer,

4) Three Magnetic Tape Cassette Units, and
5) System Status Panel.

The basis of the data acquisition system was a Data General NOVA 1200 minicomputer. The NOVA, with a basic cycle time of 1.2 μsec, was equipped with automatic program load and power fail/automatic restart features. The computer utilized 8K 16-bit words of core memory. Analog-to-digital conversion was accomplished via an ADC built by Radian Corporation. The input/output unit for the system was via a teletype keyboard/printer. This teletype provided keyboard entry and hardcopy printed output. The data were also recorded on a cassette magnetic tape unit with three drives. The cassette unit was utilized for program storage and loading as well as recording. The power to the teletype and cassette units was turned on only when the unit(s) was to be used to reduce wear on mechanical parts.

3.0 QUALITY ASSURANCE PROCEDURES

Many factors are important in the collection of acceptable air quality data. These include stable, well-maintained instruments, a suitable environment for those instruments, a well-designed sampling system that provides unaltered samples of the ambient air, reliable reference gases, detailed records of all activities, and proper operating procedures for the monitors. In addition, it is desirable to perform periodic calibrations and control-sample audits to assess the uncertainty in the ambient data.

The monitoring stations in southern Louisiana were subjected to a stringent quality assurance program in order to substantiate the validity of the data and to detect any possible errors. Emphasis was placed on multi-point calibrations, audits, and zero/span checks. In addition to external audits by Radian personnel, the stations were also audited by EPA personnel on an unannounced basis. The publication, Guidelines for Development of a Quality Assurance Program; Reference Method for Measurement of Photochemical Oxidants, EPA-73-028c, was used as a guideline.

Calibration, audit, and span values for ozone were based upon the neutral buffered potassium iodide (NBKI) method as written in the Federal Register, Volume 36, No. 84, Part II, April 30, 1971. This technique, although under intense scrutiny, is the reference method for calibrating ozone analyzers. However, the ozone sample values were also checked using reverse gas phase titrations to provide secondary documentation. Values presented in this report are based on NBKI results.

The NO_x analyzers were calibrated and audited by dilution of Standard Reference Material (SRM) cylinders of NO in

nitrogen obtained from the National Bureau of Standards. The converter efficiency was checked periodically by gas phase titration of NO with ozone. Commercial cylinders of NO in nitrogen, referenced to the SRM used for multi-point calibrations, was used as the source for daily span values.

The SO_2 analyzers were calibrated and audited using SO_2 permeation devices. All permeation tubes were certified by the National Bureau of Standards.

All continuous analyzers were multi-point calibrated monthly. After monitoring began, external audits were conducted by both Radian and EPA personnel. For the external quality assurance audits, reagents, gases, glassware, calibration equipment, and personnel were all different than that involved in the multi-point calibration.

All instruments were automatically zeroed and spanned once each day by computer control. Each instrument was first switched to zero and a supply of zero air was introduced to the analyzers. The computer monitored the output of each channel and took a new zero reading after a stable zero signal had been reached. This zero reading was compared by the computer to the zero reading obtained 24 hours earlier. Next, span gas was supplied to each channel, and the computer decided when a stable span value had been reached. This value was recorded and compared to the previous day's value. The instruments were then returned to the monitor mode and after two minutes the computer resumed data taking. If either the zero or span value drifted by more than 10 ppb, it was noted and recorded as an excess drift. The operator could then check the system to see if a problem was developing.

The high volume TSP samplers were calibrated and audited using separate orifice calibration kits from General Metal Works. Calibrations were performed monthly. Audits were conducted seven times on each sampler. Five resistance plates were used for calibrations and audits. The calibration of these plates were traceable to a Roots-Connerville meter.

In addition to the above features, the quality assurance program for this study also included the following features:

1) The inside station temperature was continuously monitored to insure that the instruments had a stable environment. If the interior temperature became too high, a related feature included an automatic shutdown of the system to protect the components.

2) Line voltage was continuously monitored to detect if there were any drops or surges that might affect instrument performance.

3) All flows were checked using either NBS-certified bubblemeters or mass flow controllers that had been referenced to NBS-certified bubblemeters.

4) The air sampling manifold was heated slightly to prevent water condensation. A high flow rate was maintained to minimize residence time. All system components were glass or Teflon.

5) A sensor was mounted in the sample line to signal the computer if the manifold fan malfunctioned.

6) Permeation tube oven temperatures were checked before each calibration.

7) The linearizer circuits in the SO_2 analyzers were electronically re-aligned monthly.

8) The stations were visited daily by trained personnel.

9) Detailed logbooks were maintained in each station.

10) A detailed checklist was completed daily at the station to assure proper operation of the system.

11) A hardcopy printout of all data (including automatic zero/spans) was provided hourly at each station. Data were checked daily for indications of problems.

12) The data acquisition system was totally automated to eliminate human errors in data.

13) The discrimination of the data acquisition system exceeded that of the analyzers.

14) The computer was equipped with automatic restart after power failures. The analyzers also re-started automatically. The time and duration of the power failure was recorded and printed on the hard copy.

15) Statistical significance of the data was assured by sampling all data channels once per second. Five-minute averages were calculated and stored.

16) The computer monitored and controlled many parts of the system. Problems were indicated visually by lights in the System Status Panel and by the hardcopy printout. All problem indications were also recorded on cassette tapes. Examples of monitored parameters include:
   (a) excess zero drift
   (b) excess span drift
   (c) shelter temperature
   (d) line voltage
   (e) manifold fan operation
   (f) manifold temperature
   (g) instrument power

17) Data were recorded on two independent cassette tapes and hard copy.

The purpose of these quality assurance features was to produce and substantiate valid data. The primary means for validating data were the calibration and audit results. For ozone and SO_2 data to be considered acceptable, it had to be bracketed with a milti-point calibration and subsequent quality assurance audits with the audit results being within ±15 percent of the control-sample value. For oxides of nitrogen data to be considered acceptable, audit results had to be within ±20 percent of the control-sample value. These specific percentage values for valid data were established by EPA.

In addition to the audit results, decisions were also based upon the results contained in the daily checklists, station logs, and additional monitored parameters such as inside temperature and line voltage.

Data compiled during the Louisiana study were divided into two classes. Class I data includes all data that compiled with the limits for valid data. Class II data included all data that was obtained during the course of the monitoring. An analysis of the statistical error associated with auditing the analyzers is found in the quality assurance report.[1]

4.0 RESULTS AND ANALYSES

The purpose of this section is to present the most important data summaries for the monitoring program and to summarize the results of the detailed analyses which are presented elsewhere.[2,3,4] The results and analyses presented in this section apply to only the Class I data.

4.1 Data Summaries - Gross Correlations

Table 4-1 summarizes the ozone data collected at each of the nine monitoring locations. The major observations one can make from Table 4-1 are the following:

- The frequency of observations exceeding the 80 ppb standard for ozone at the nine sites ranged from four to seventeen percent of available observations with ten percent of the total number of observations exceeding a concentration of 80 ppb.

- Five percent of the total available observations exceeded a concentration of 100 ppb.

- Because of the variations of the number of observations available at various sites (a factor of 2.37 between sites 013 and 019) and uncertainty regarding the hours of the day and the days of occurrence, it is not realistic to utilize this summary for comparing sites. This is readily apparent when data availability by site is examined in Figure 4-1.

TABLE 4-1. Summary of O_3 Data

July 17 - October 17, 1976

Site ID #	Location	O_3 Geometric Mean (ppb)	Total Class I O_3 Hours	Number >80 ppb	Number >100 ppb	2nd High (ppb)	1st High (ppb)
008	St. Gabriel	24	1,485	248	132	187	188
010	St. Alma	18	1,651	85	36	174	211
012	Norco	18	962	39	16	155	158
013	Galliano	25	847	123	76	157	164
014	NASA	25	1,251	119	57	147	171
016	Morgan City	25	1,889	147	89	194	203
017	St. James	25	867	112	54	142	148
018	Vinton	17	1,211	76	32	139	143
019	Lafayette	24	2,004	232	106	148	149
	TOTAL	22	121,167	1,181	598		

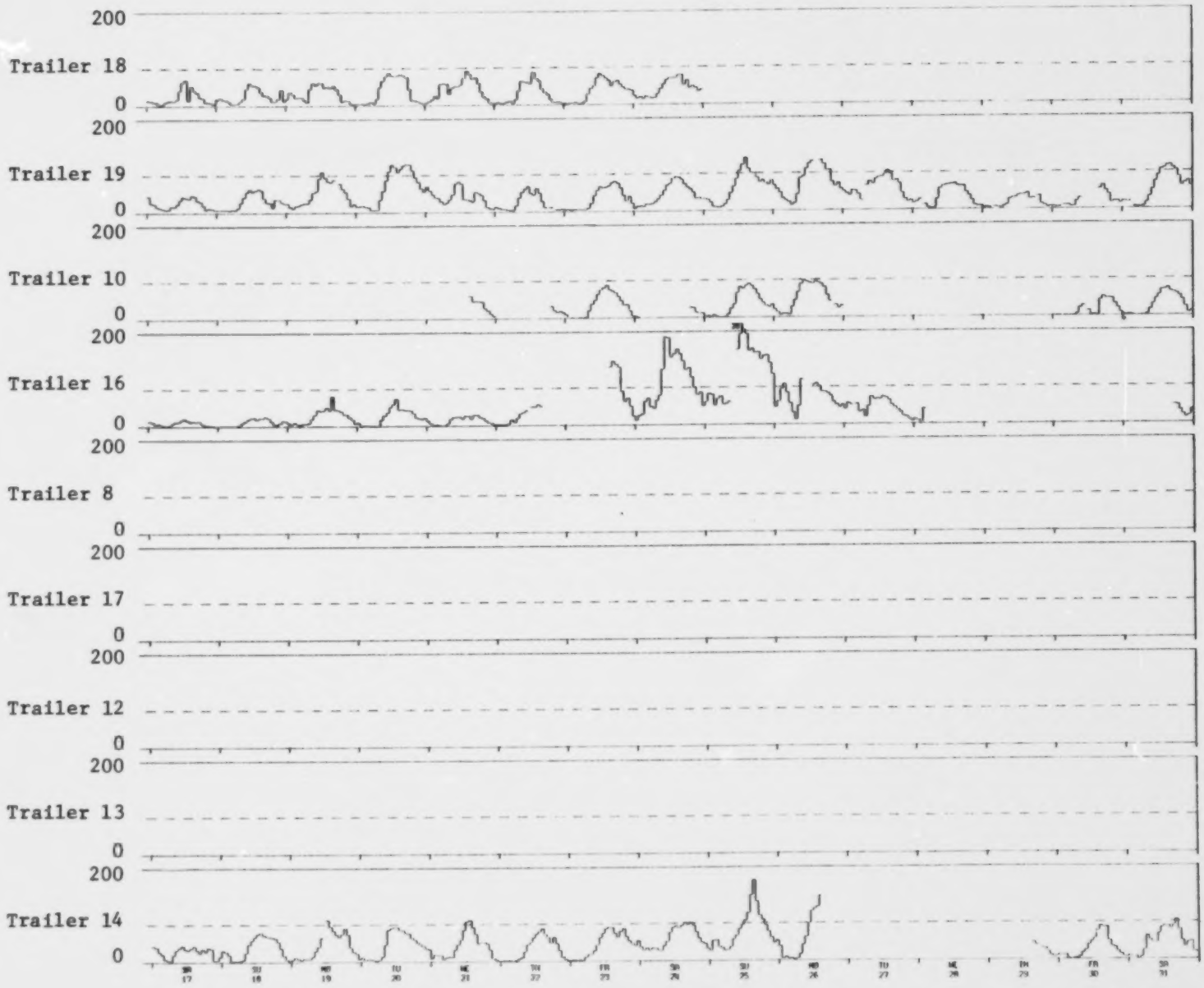


Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
July 17-31, 1976

(Continued)

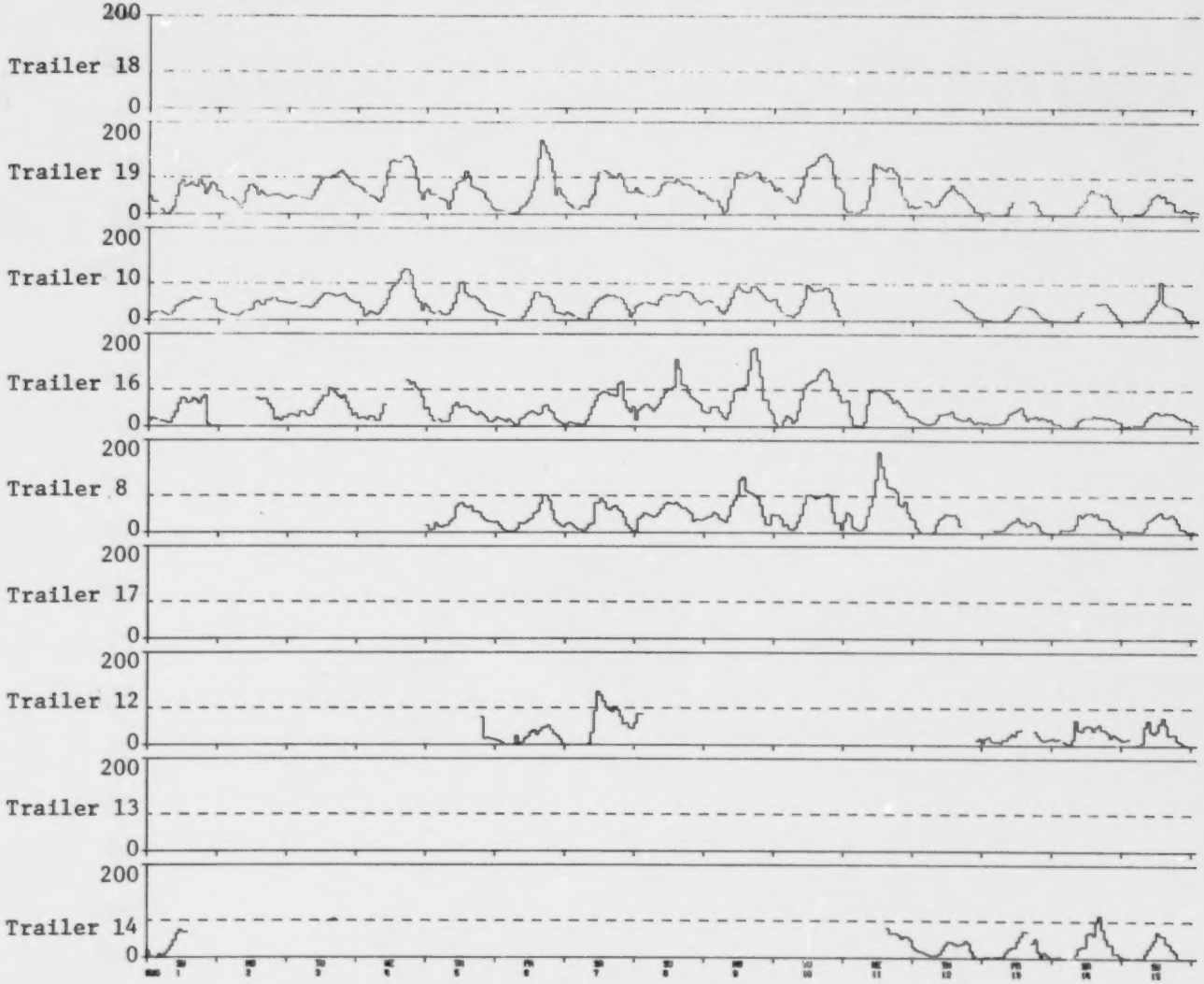


Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
August 1-15, 1976

(Continued)

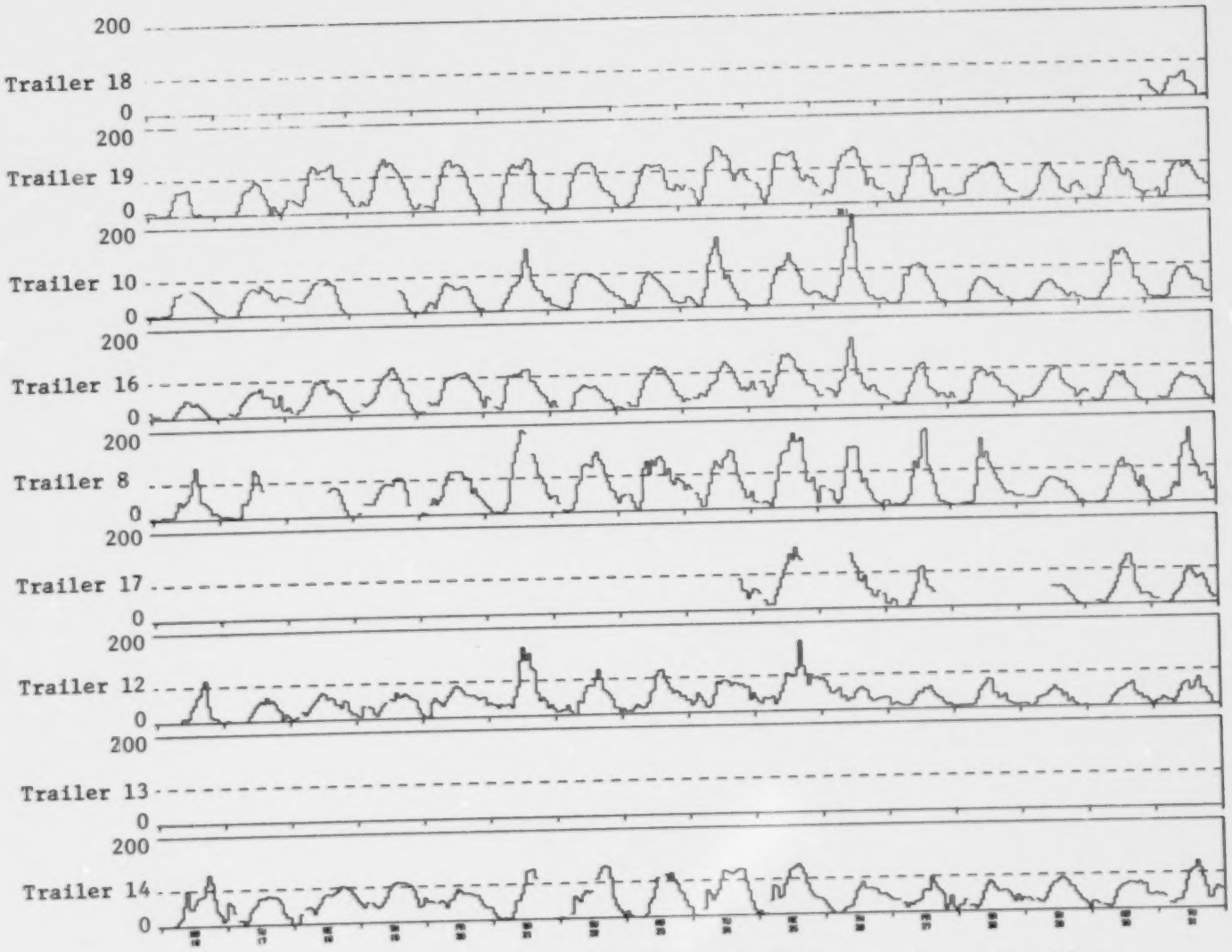


Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
August 16-31, 1976

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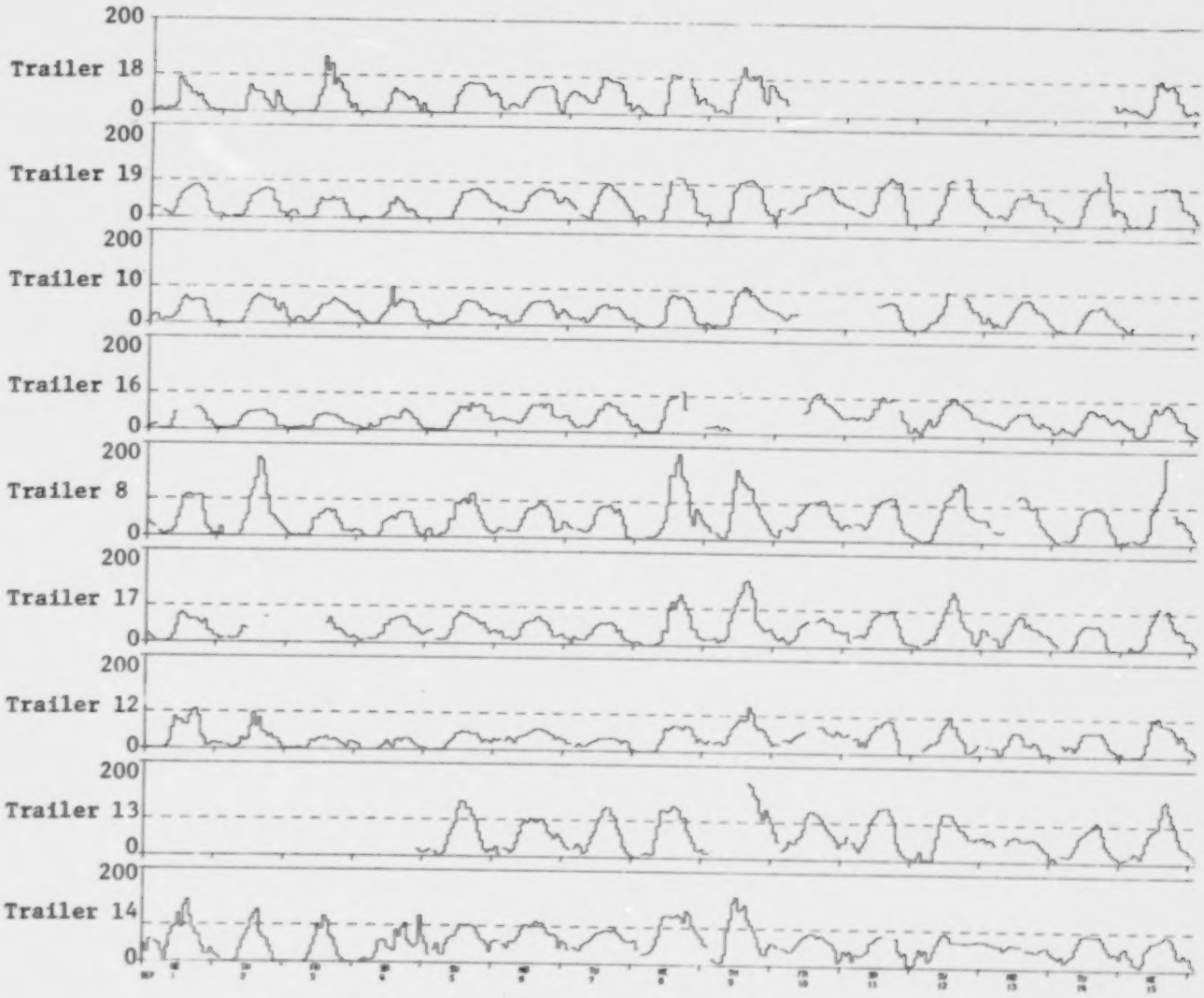

Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
September 1-15, 1976

(Continued)

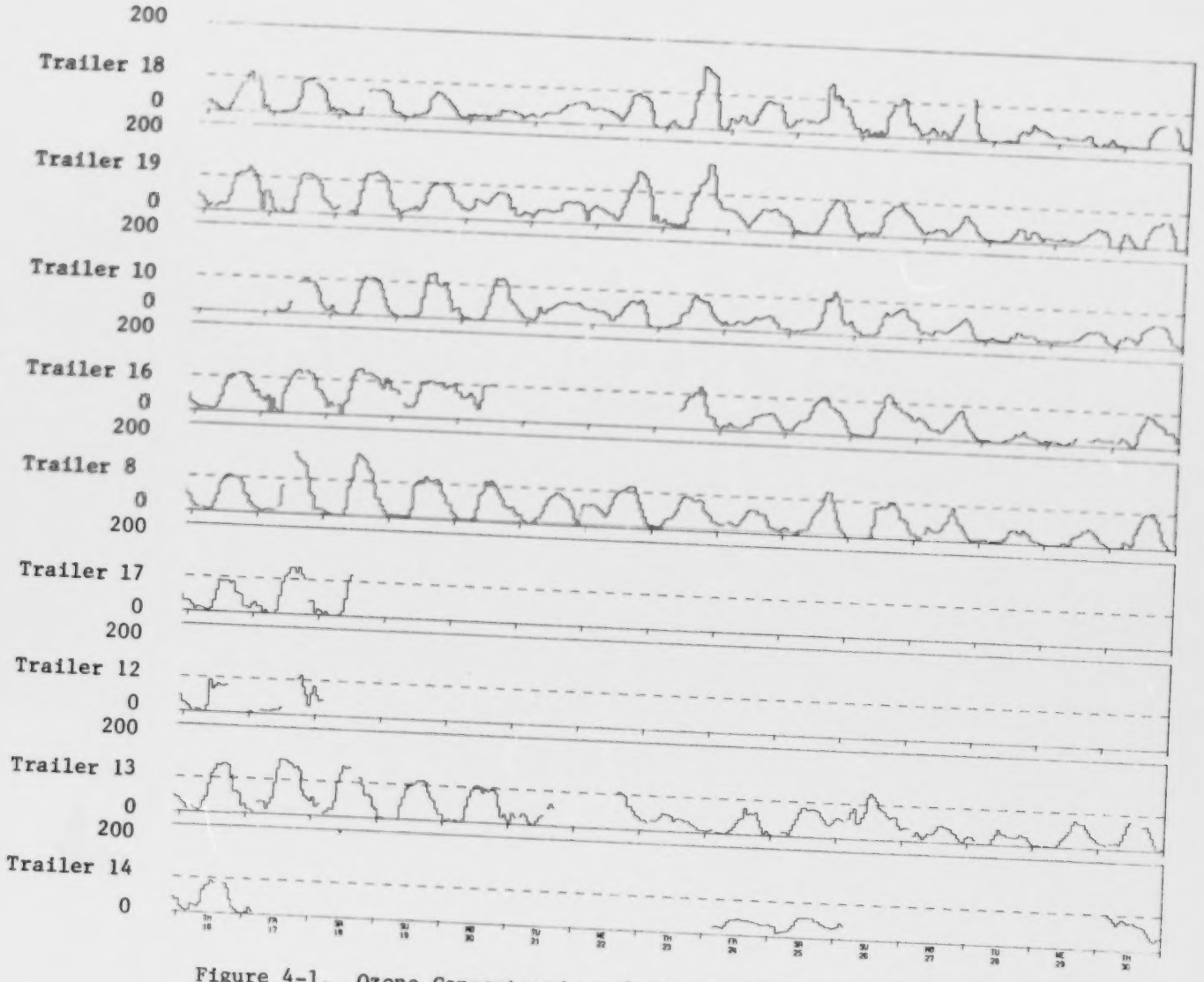

Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
September 16-30, 1976

(Continued)

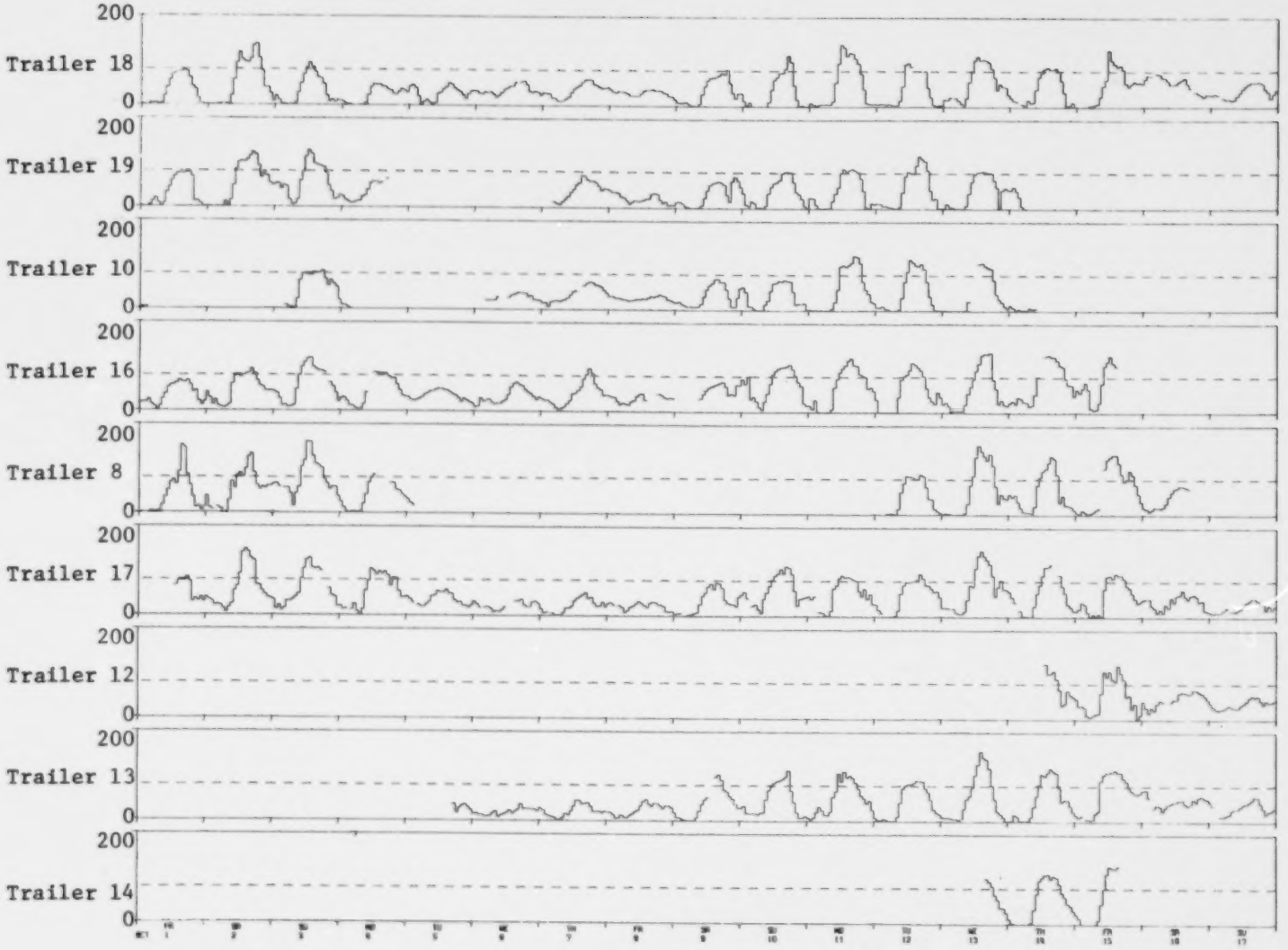

Figure 4-1. Ozone Concentrations (ppb) at the Trailer Monitoring Sites
October 1-17, 1976

- For all nine sites, the second highest ozone concentration during the three-month study period is roughly twice the 80 ppb standard level.

Figure 4-1 displays graphically the entire set of Class I ozone data. Again, several major observations can be made.

- The diurnal pattern of extreme daytime highs followed by extreme nighttime lows implies a general condition of polluted air through most of the study period for all monitoring locations.

- There are numerous and frequent excursions above the 80 ppb standard level.

- There are identifiable periods of overall low ozone concentrations for all areas (e.g., September 28 through 29, and October 5 through 8).

- Days of highest ozone concentrations show high readings through much of the study area.

Gross correlation analyses can be made from pollutant data sorted by wind direction, time of day, and day of week. Tables 4-2, 4-3, and 4-4 display these breakdowns for O_3 for each of the nine monitoring locations. The numbers shown in Tables 4-2, 4-3, and 4-4 are geometric means of hourly average ozone concentration. Appendix B contains similar tables for NO_x, NO, and SO_2. The number of observations used in computing

TABLE 4-2. WIND DIRECTION DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF OZONE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	40	33	34	34	40	52	35	42	44	49	45	53	47	45	36	22	6	24
10	38	23	19	24	29	19	22	34	28	25	32	26	31	30	35	31	4	18
12	42	33	38	34	18	23	31	25	20	21	14	15	10	20	19	21	6	18
13	38	28	26	33	48	39	32	25	42	48	30	29	32	16	14	13	10	26
14	38	31	32	43	51	65	51	44	36	22	19	15	6	28	39	39	6	25
16	37	30	42	34	30	36	42	54	55	47	41	44	33	39	31	30	11	27
17	31	17	27	37	40	54	46	49	31	29	27	25	19	21	17	19	5	25
18	29	34	37	40	31	43	42	41	48	46	45	42	43	37	23	22	7	17
19	40	34	26	27	39	32	41	33	21	21	22	21	22	22	21	18	4	24

TABLE 4-3. HOUR OF DAY DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF OZONE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	10	8	6	7	6	6	6	7	18	37	55	70	78	81	83	80	75	71	59	43	29	20	13	10	24
10	8	6	5	4	5	4	4	5	13	26	40	53	56	58	57	56	57	54	47	35	24	17	13	10	18
12	8	7	7	13	7	7	6	7	12	25	34	42	49	51	52	52	50	45	39	28	20	14	12	10	18
13	11	10	9	10	8	8	6	7	16	31	45	55	61	69	69	70	70	68	57	46	36	25	20	17	25
14	11	9	9	9	8	8	9	12	24	39	51	60	67	68	71	69	63	60	53	39	30	21	16	11	25
16	13	12	11	10	10	8	7	9	20	36	46	54	60	62	62	61	59	55	49	40	31	25	19	16	25
17	17	14	12	8	8	6	5	5	14	27	46	57	69	74	72	70	68	60	49	39	30	25	19	19	25
18	8	8	7	6	6	6	5	5	13	31	45	57	58	57	54	54	51	45	38	22	12	10	9	8	17
19	13	12	10	9	8	6	6	6	16	34	50	62	67	69	70	70	65	62	56	39	24	19	16	13	24
TOTAL	11	9	8	7	7	6	6	7	16	32	46	57	63	65	65	64	62	57	50	37	25	19	15	12	22

TABLE 4-4. DAY OF WEEK DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF OZONE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	28	25	23	25	23	21	22	24
10	19	22	20	18	20	14	13	18
12	16	15	17	20	24	18	20	18
13	29	29	19	22	22	29	30	25
14	23	27	34	38	21	18	22	25
16	27	27	22	21	25	25	27	25
17	31	29	28	22	24	23	25	25
18	15	16	18	19	15	18	19	17
19	24	27	27	27	24	19	19	24
TOTAL	23	24	22	23	22	20	21	22

each entry in Tables 4-2, 4-3, and 4-4 and in the Appendix B tables are given in Appendix C.

Upon examination of the wind direction, time of day, and day of week dependence tables one may make the following observations:

- At all sites the diurnal variation in ozone levels are typical of polluted urban air. The maximum ozone levels occur between 1 and 5 p.m. and the minimum levels occur between 4 and 7 a.m.

- There is no evident day of week dependence of ozone levels. There are obvious differences between stations in the daily variation in the geometric mean, although no physical significance of this variation is clear.

- Overall the NO_x and SO_2 levels at all of the monitoring sites are very low.

- Trailers 012 and 014 appear to be significantly influenced by NO_x from the New Orleans area. However, the maximum geometric mean at trailer 017 occurred with calm winds. This concentration (26 ppb) experienced with calm winds was the highest recorded geometric mean concentration of the wind distribution tables for NO_x. It was derived from 130 observations and can therefore be considered representative of summertime values at that location. Trailers 008, 010, and 019 near Baton Rouge and Lafayette showed much lower concentrations of NO_x when the wind was from those

cities than did the trailers (012 and 014) near New Orleans. As would be expected, concentrations of NO_x were generally lower than would be found in or near a city center observation site.

- Trailer 017 at St. James came closest to the diurnal concentration pattern typical of cities. This is probably due to the proximity of Louisiana Highway 18 to the trailer site and the fact that this highway is the main traffic artery for workers in the plants on the South side of the Mississippi River. Most of the trailer sites experienced a very minor increase in concentration during the morning hours. Site 018 near Vinton has the highest concentration of NO_x between 8 and 12 p.m. This may reflect NO_x transported into Vinton from the Houston, Port Arthur, Beaumont, or the Lake Charles areas. This hypothesis is supported to some extent by the fact that the highest geometric mean values of NO_x at Vinton occurred with winds from the South Southwest and from the East. Further investigation, not a part of this study, would be required to verify this influence.

- It is difficult to discern a clear day of the week dependence of NO_x. Overall Friday appears to be the day of the week with highest NO_x levels. One site, 017, appears to experience higher levels on Wednesday through Friday than on the other days of the week.

- The NO levels exhibit trends that appear to be similar to the NO_x trends. This observation is somewhat less clear cut than the observations for NO_x.

- Only trailer 017 reported SO_2 values indicating the likelihood of an industrial source or, more likely, two different sources. This is indicated by the increase in concentration of SO_2 which occurred with a wind from the North Northeast and from the South Southeast, higher concentrations occurred between the hours of 9 a.m. and 6 p.m. and during the week than on Sundays. Trailer 012 indicated a slight increase in concentrations of SO_2 with a wind from the West Southwest, no apparent hour of the day dependence and some indication of very slightly higher concentrations on Friday, Saturday, and Sunday.

- No relation between wind from urban areas and SO_2 levels could be found.

To investigate the dependence of ozone concentrations upon the interactive influences of wind speed, wind direction, and time of day, a more detailed breakdown than shown in Tables 4-2, 4-3, and 4-4 is required. Table 4-5 through 4-13 provide a more detailed breakdown. The day is divided into three periods - mignight to 0800, 0800 to 1600, 1600 to midnight - corresponding approximately to stabilized low ozone, ozone formation, and ozone removal periods, respectively. The wind direction is broken down into sixteen 22½° sectors, and the wind speed into three categories corresponding approximately to calm, light, and moderate wind conditions. In Tables 4-5 through 4-13, an entry is circled if it has been computed for less than three

observations. The number of observations corresponding to each entry in these tables may be found in Appendix C.

The following are the major observations that can be drawn from Tables 4-5 through 4-13. It should be emphasized that these comments refer to the geometric mean values other than the more frequently considered extreme values from single incidents.

Day 8 a.m. - 4 p.m.

- Calm or nearly calm conditions (0 to 2 mile per hour wind speeds) show noticeably lower ozone concentrations than the higher wind speed classes. However, this effect is less pronounced during this period than during other periods.

- The highest ozone levels of all tend to occur with light wind speeds (3 to 6 miles per hour) during this period.

- For the 3 to 6 mile per hour wind speed category, all sites show the highest ozone concentrations when the wind is from the southeast quadrant with the exception of site 018 (Lake Charles) which shows the highest levels when the wind is from the southwest quadrant.

- For higher wind speeds (greater than 7 miles per hour) there appears to be a less consistent pattern of wind direction dependence between the sites. In particular, sites 008, 010, 013, and 014 continue to show moderate to strong dependence in the southeast quadrant during the higher wind

TABLE 4-5.

OZONE — GEOMETRIC MEANS - SITE 8

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	7	8	7	5	5	4	4	4	4	5	7	13	8	12	6	3	6
3-6	(24)	30	25	11	26	18	(36)	(26)	(3)	26	18	25	13	(45)	28	(12)	21
GE 7									(32)			(28)	(8)				19
ALL	12	12	9	5	6	4	4	4	5	7	8	15	9	14	7	3	7

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		34	28	40	30	50	50	39	51	65	48	66	89	59		(10)	43
3-6	(52)	49	52	45	60	77	83	91	81	104	55	74	80	76	72	24	65
GE 7	(72)	67	81	64	81	83	(80)	(53)		(29)	67	(84)	(37)	50	38	68	61
ALL	55	46	43	48	48	64	62	51	65	79	54	73	78	65	56	29	56

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(15)	27	27	14	28	20	12	23	14	29	28	35	30	18	8	27	21
3-6	(29)	47	68	52	43	54	62	40	38	53	55	54	83	66	36	54	51
GE 7	(69)	74	(64)		67	76		(59)		(45)	54	(47)	(56)	(78)	59	52	64
ALL	47	42	37	22	38	37	19	26	22	38	40	43	38	28	19	41	32

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	11	12	11	9	11	12	9	13	14	15	19	25	23	19	7	6	13
3-6	31	38	47	39	49	57	68	59	53	63	51	61	62	69	50	30	52
GE 7	70	70	62	64	74	79	(80)	55	(32)	33	61	54	28	58	43	59	60
ALL	29	20	20	19	20	25	14	22	24	27	33	41	36	31	20	16	24

◯ - indicates less than 3 observations.

TABLE 4-6.

OZONE GEOMETRIC MEANS - SITE 10

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		9	4	3	3	3	6	8	7	5	5	5	9	6	19	5	4
3-6	29	26	21	15	(28)	(10)	(41)	28	21		(21)	5	13	(20)	18	19	18
GE 7	(31)	(32)	(23)	(25)												21	24
ALL	30	12	4	3	3	3	6	10	9	5	6	5	10	7	18	16	5

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(92)	(45)	15	18	28	28	30	51	49	39	45	34	51	43	(16)		30
3-6		27	35	40	59	56	53	58	55	60	60	46	32	44	42	29	46
GE 7	(37)			38	51	58	(43)	45	(58)		35	(29)	(52)	44	37	41	42
ALL	50	30	27	31	48	43	41	58	54	46	49	42	35	44	39	33	40

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		(21)	11	12	14	14	20	25	21	26	36	36	45	18	32	(38)	19
3-6	53	32	43	34	35	47	48	37	41	45	49	39	50	39	40	47	42
GE 7	(18)			(53)	49	62	(43)	(50)	(41)			(62)			49	56	52
ALL	50	29	13	16	20	18	23	29	29	31	40	38	48	30	39	48	27

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(92)	10	5	5	7	8	14	23	16	17	23	22	25	13	28	12	18
3-6	35	28	34	34	49	50	51	49	42	52	51	28	34	42	37	34	39
GE 7	36	(32)	(23)	38	50	60	43	50	46		35	48	(52)	44	40	34	42
ALL	38	16	5	9	14	12	19	31	26	23	32	26	31	30	36	31	18

(○) - indicates less than 3 observations.

TABLE 4-7.

OZONE GEOMETRIC MEANS - SITE 12

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		(12)	(13)	3	2	3	5	4	4	5	5	3	7	10	10	8	5
3-6	(19)	17	21	23	8	8	(6)	(12)	15	(15)	2	2	6	7	3	2	8
GE 7	45		35	22	9	(19)					(1)	1			(29)	26	18
ALL	38	16	24	17	5	4	5	5	6	6	4	2	7	9	9	9	7

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			(13)	19	(30)	64	48	39	40	55	24	46	20	29	11	26	33
3-6		60	47	46	45	34	53	(73)	57	45	43	24	14	50	32	41	48
GE 7	(51)	38	40	40	44	33		(25)			(29)	21	8	36	33	35	34
ALL	51	42	40	40	43	40	51	41	49	50	29	30	13	37	24	36	36

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		(28)	(1)	41	11	20	19	20	16	11	14	58	7	(10)	10		17
3-6	(36)	40	57	51	24	31	39	19	24	27	15	25	18	36	39	(49)	28
GE 7	47	36	46	33	32	20	(38)	(49)	(34)	47	(46)	34	(4)		54	(58)	33
ALL	44	35	31	43	18	22	22	21	21	19	15	33	13	27	30	54	23

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		(15)	8	14	6	13	14	19	10	11	10	15	9	13	10	12	12
3-6	29	29	37	40	18	26	42	28	27	30	12	13	10	29	26	28	23
GE 7	47	38	40	31	29	24	(32)	(35)	(34)	47	14	13	7	36	40	33	30
ALL	42	32	34	31	13	18	19	20	17	17	11	14	9	19	18	21	18

◯ - indicates less than 3 observations.

TABLE 4-8.

OZONE GEOMETRIC MEANS - SITE 13

HOURS 0000 TO 0800

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
WS												(1)	(10)	7	(4)	(10)	7
0-2		20	6	5	5	5	6	5	14	22	12						19
3-6	(18)	26	18		16	(37)			(38)	(61)	(25)		(68)	(12)	11	9	38
GE 7		(49)			25												
ALL	(18)	25	9	5	7	7	6	6	15	28	11	(1)	26	8	9	11	9

HOURS 0800 TO 1600

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
WS																	23
0-2			10	25	35	37	(42)	(22)	(103)			(22)					
3-6		25	62	52	83	65	77	(117)	56	13	56	(62)	(16)	47	43	14	53
GE 7			64	46	57	71	(64)	(100)	(42)	(83)	72	50	(72)		26	(15)	54
ALL		25	34	44	65	58	61	62	62	32	63	45	44	47	35	14	47

HOURS 1600 TO 2400

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
WS																	26
0-2		(43)	32	29	18	32	38	33	55	(85)	(3)	(31)		(1)	3		51
3-6	(81)	(72)	72	46	30	54	55	61	75	(88)	48	(31)		(13)	27		46
GE 7			(88)	28	56	(27)	(34)	(35)	(37)	(66)		(33)		55	(44)		36
ALL	(81)	56	49	33	28	38	40	40	58	81	32	32		18	11		

HOURS 0000 TO 2400

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
WS												9	(10)	5	3	(19)	13
0-2		26	11	12	10	19	19	14	25	38	9						
3-6	(38)	28	42	49	57	57	64	73	67	45	48	(44)	42	25	19	11	41
GE 7		(40)	57	37	52	56	42	53	56	73	72	47	(72)	55	30	(15)	50
ALL	(38)	28	23	21	27	33	25	22	42	48	30	29	32	16	14	13	26

◯ - indicates less than 3 observations.

TABLE 4-9.

OZONE GEOMETRIC MEANS - SITE 14

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		10	14	13	17	13	22	14	3	6	7	4	3	5	12	20	6
3-6	(22)	24	25	30	16	31	28	47	(23)	(8)	(35)	9	4	31	35	25	20
GE 7	(15)	31	42		49	55						(56)	(32)				39
ALL	(28)	24	28	17	23	25	24	19	4	6	8	5	3	6	18	22	9

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		34	30	36	47	75	47	58	73	25	(29)	35	27	16	38	(41)	43
3-6	(55)	45	45	46	61	77	62	51	76	58	59	54	52	60	62	50	60
GE 7	(53)	51	47	52	59	64	71	(56)	(49)	(45)	46	(70)	49	56	37	52	52
ALL	(51)	43	41	44	57	75	55	58	70	37	52	47	44	51	50	50	53

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			44	35	43	56	52	34	23	18	9	10	5	9	3	(51)	18
3-6	(28)	43	45	55	63	63	52	46	50	29	23	50	23	52	(57)	36	43
GE 7	(44)	(10)	(63)	46	55	63	55	55	(65)	45	(39)	67		(27)	(53)		52
ALL	38	34	45	45	57	61	52	41	34	23	15	17	9	33	11	40	31

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		19	28	24	36	43	44	30	13	12	9	7	3	6	11	29	12
3-6	34	32	36	44	54	70	52	47	53	28	31	34	17	53	53	39	42
GE 7	41	32	47	49	57	61	59	60	56	45	44	64	44	53	39	52	50
ALL	38	29	31	36	50	61	50	37	24	15	15	12	6	21	30	38	25

◯ - indicates less than 3 observations.

TABLE 4-10.

OZONE GEOMETRIC MEANS - SITE 16

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(1)	6	8	6	7	9	9	11	9	12	11	14	10	20	15	32	9
3-6	25	23	29	17	20	25	(15)	(37)	29	(18)	(1)	(5)	12	13	18	10	19
GE 7	26	27			33	(33)										21	26
ALL	21	10	10	7	9	10	9	13	10	12	9	13	10	17	15	20	11

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		42	55	26	25	26	47	36	51	58	63	71	43	44	44	(31)	41
3-6	61	52	53	61	61	48	65	65	62	57	49	45	47	53	49	24	55
GE 7	58	(25)	(110)	54	45	62	67	51	(13)	69	64	(78)	(81)	(59)	52	33	53
ALL	59	52	59	45	42	34	58	54	58	59	54	56	47	51	49	27	50

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		54	24	21	20	25	31	48	32	37	25	24	24	20	16	25	28
3-6	29	38	38	30	37	48	53	58	69	65	57	51	41	58	24	47	46
GE 7	99	58	(54)	(44)	55	21	(33)	(26)	(44)	(64)	57	63	(43)	(54)	42	68	56
ALL	50	43	32	28	28	28	35	50	41	44	40	35	29	33	21	47	36

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(1)	9	15	13	12	15	21	33	22	27	21	24	17	23	17	30	18
3-6	30	36	51	42	41	42	57	61	61	56	50	41	39	39	35	27	44
GE 7	57	37	77	71	49	33	72	45	30	68	59	68	(59)	53	50	37	50
ALL	33	20	27	19	22	19	27	43	36	36	33	31	23	32	26	30	27

◯ - indicates less than 3 observations.

TABLE 4-11.

OZONE GEOMETRIC MEANS - SITE 17

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		5	5	11	5	4	4	9	2	9	11	5	9	6	6	4	7
3-6	10	14	9	11	26	22	18	(15)	(11)	10	21	9	6	19	8	10	13
GE 7	(31)				39										13	15	19
ALL	21	9	6	11	14	7	6	9	3	9	12	5	9	8	7	9	8

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		17	21	40	57	77	106	59	(67)		(35)	(105)	14	9	(12)	(20)	44
3-6	(71)	33	41	55	58	75	56	69	50	47	61	90	39	41	36	55	53
GE 7		(67)	47	55	64	(69)		53		(47)		(58)	(33)	(37)	32	17	39
ALL	(71)	29	34	48	53	76	77	52	55	47	51	76	25	27	32	25	47

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			(23)	(49)	9	35	64	42	24	29	13	25	27	21	18		27
3-6	(51)	(23)	45	35	44	46	41	58	52	51	51	43	42	24	26	31	43
GE 7	33		39	34	43	56	(32)	(48)	(38)		(58)	(57)		(46)	24	28	37
ALL	34	(23)	40	35	35	45	54	46	31	38	38	31	32	23	22	29	35

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		7	14	31	20	36	33	24	17	16	12	10	13	10	8	5	16
3-6	28	19	34	37	47	56	39	56	46	38	44	34	22	28	15	25	35
GE 7	32	(64)	44	45	50	59	(32)	52	(30)	(47)	(56)	50	(33)	40	25	19	35
ALL	31	14	27	36	36	45	35	40	24	24	20	15	15	17	15	17	25

○ - indicates less than 3 observations.

TABLE 4-12.

OZONE GEOMETRIC MEANS - SITE 18

HOURS 0000 TO 0800

MS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	10	11	6	5	7	4	4	5	3	4	3	5	4	12	6	11	5
3-6	18	(45)	(33)	(73)	(22)	(66)	33	(75)	(8)	20	43	21	(39)	(17)	25	38	28
GE 7														(27)			(27)
ALL	12	12	7	6	8	5	5	6	3	4	3	6	5	13	9	13	6

HOURS 0800 TO 1600

MS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(28)	29	28	43	30	43	49	48	51	37	48	29	34	37	26	12	40
3-6	(52)	29	45	71	41	48	59	51	65	74	64	72	62	48	24	16	46
GE 7	(33)	35	(47)			(41)		(56)		(58)					29	(25)	35
ALL	36	31	38	48	33	45	53	49	54	47	53	36	43	38	25	16	42

HOURS 1600 TO 2400

MS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	36	42	33	19	12	20	17	9	13	12	12	15	18	20	14	20	15
3-6	54	55	47	(35)	(33)	27	45	43	53	53	51	(58)	(6)	(39)	31	36	43
GE 7	(34)								(33)					(28)	(26)		38
ALL	40	47	36	19	14	22	20	12	20	18	15	18	16	22	23	25	19

HOURS 2000 TO 2400

MS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	15	16	12	13	14	14	14	15	11	11	8	11	12	21	9	12	12
3-6	33	38	44	57	36	43	52	49	53	54	58	43	48	37	26	25	42
GE 7	(31)	35	(47)			(41)		(55)	(33)	(59)				(27)	28	(23)	34
ALL	21	22	17	18	17	21	19	19	16	16	12	14	15	24	15	16	17

◯ - indicates less than 3 observations.

TABLE 4-13.

OZONE — GEOMETRIC MEANS - SITE 19

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	(18)	7	7	7	7	5	8	7	4	4	4	5	4	5	4	10	5
3-6	(19)	25	13	23	30	18	(46)	22	7	15	27	15	13	15	15	11	18
GE 7	(31)	(31)			(26)							(18)	16		21	36	24
ALL	26	20	8	9	9	6	9	8	4	5	7	8	7	8	8	13	8

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			32	25	41	39	61	42	20	34	34	38	51	37	33	(1)	34
3-6		46	42	54	65	71	72	53	54	49	47	42	45	56	47	38	53
GE 7	(55)	49	75	83	58	62	56	(41)	57	(75)	47	(51)	34	45	40	28	52
ALL	(55)	47	45	49	56	62	67	55	42	48	45	42	43	51	44	23	49

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	34	46	12	27	33	25	19	14	10	13	9	7	5	4	16	9	15
3-6	45	65	75	54	73	61	52	40	40	35	35	38	47	20	27	24	44
GE 7	(46)	67	75	75	87	(58)	60	59	61	45	42	60	33	58	51	39	56
ALL	43	55	43	43	56	40	27	30	25	26	23	23	32	13	27	23	31

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	35	23	10	10	17	11	15	13	7	7	6	7	5	6	7	8	10
3-6	41	35	41	46	64	62	65	49	41	36	37	29	33	30	30	18	48
GE 7	45	50	75	65	61	61	56	57	59	51	44	48	28	51	38	34	51
ALL	40	33	25	25	35	26	31	27	18	18	19	19	19	19	20	18	24

◯ - indicates less than 3 observations.

speed conditions while sites 012, 016, and 017 shift dependence to the northeast quadrant. (New Orleans is in the northeast quadrant for sites 012, 016, and 017.)

Night 4 p.m. - 8 a.m.

- Calm or nearly calm conditions (0 to 2 mile per hour wind speeds) show noticeably lower ozone concentrations than the higher wind speed classes.

- The higher ozone levels tend to occur with high wind speeds (greater than 7 miles per hour).

4.2 Meteorological Associations

An investigation into the relationships of synoptic, regional, and local meteorology to ozone levels (see reference 2) revealed that high ozone levels during the monitoring period generally occurred on sunny days with light winds and high temperatures. Periods of regionwide low ozone levels were primarily associated with widespread thunderstorm activity across southern Louisiana.

Cold fronts which passed through the region were conducive to nighttime ozone levels which were higher than nighttime levels which were typically observed during the study period. Strong winds during the study period were conducive to low ozone levels and light winds were conducive to high levels, although low ozone levels with light winds were not uncommon. No clear relationships were observed between ozone levels and dew points, and ozone levels and the curvature of pressure systems.

The investigation into the relationships between ozone levels and meteorology did not contradict any known associations between meteorological parameters and ozone levels. This investigation substantiates the fact that relationships between meteorology and ozone levels are complex, due to the interrelationships of individual meteorological parameters. Furthermore, reactions involving ozone and ozone precursors and scavengers add to the complexity of determining ozone-meteorology relationships.

4.3 Transport Considerations

The potential for short- and long-range transport were investigated. Reference 3 discusses in detail the methodologies employed in that investigation. This section presents the major findings of that analysis.

The results of these case studies indicate that heavy local emissions of ozone precursors in the Baton Rouge area cause a pronounced increase in the ozone levels of nearby sites downwind, and a lesser, but noticeable increase of ozone at sites up to about 45 miles downwind, with abundant sunshine. Similar effects of precursor sources in the New Orleans area could not be determined except for long distances (about 30 miles) downwind because of unfavorable prevailing winds.

Two sites near the coast experienced a slower than normal decrease in ozone concentrations in the evenings when the air was being advected from offshore.

Ventilation (average mixing layer wind speed times mixing depth) appears to strongly influence ozone concentrations, with poor ventilation associated with the higher concentrations of ozone and good ventilation being associated with the lower

concentration of ozone. Also, large shower areas with heavy cloud cover were observed to be associated with low ozone levels.

4.4 Statistical Correlations

Reference 4 includes a detailed statistical analysis of the factors affecting ozone concentrations. The correlations between ozone concentration and other quantities, including meteorological and spatial variables and concentrations of other pollutants, were analyzed. Several variables, such as wind speed, wind persistence, and solar radiation, were shown to have measurable relationships with ozone concentration. Solar radiation had the highest correlation, .39. The statistical dependence between certain independence variables, such as wind speed and wind persistence, was analyzed as it relates to ozone concentration.

A regression model was developed from 273 data points to predict average ozone concentration between 10 a.m. and 4 p.m. Meteorological and spatial variables were used as predictors. The multiple correlation coefficient is .73, and the standard error is 18 ppb.

5.0 CONCLUSIONS

Gross Correlations

During the "oxidant season" of 1976, high ozone concentrations were recorded throughout all of southern Louisiana. The ozone data demonstrates a diurnal variation between extreme daytime highs followed by extreme nighttime lows. This diurnal pattern is similar to those typically found in urban areas. There were very few isolated ozone events, i.e., most sites recorded either high or low ozone levels on the same days. There is no evident dependence of ozone levels on day of the week. NO_x and SO_2 levels at all of the monitoring sites were very low, although these pollutants do demonstrate a noticeable dependence upon wind direction. NO_x levels increase when the wind is blowing from the urban centers. Site 017 reported SO_2 values indicating the likelihood of an industrial source, or more likely two different sources.

The highest daytime (0800 to 1600) geometric mean concentration of ozone at all sites except at Galliano (Trailer 008) occurred with light (3-6 miles per hour) wind speeds. During the periods midnight to 8 a.m., and 4 p.m. to midnight, the higher ozone levels tend to occur with high wind speeds (greater than 7 miles per hour). Calm, or nearly calm conditions (0 to 2 miles per hour wind speeds), show noticeably lower ozone concentrations overall than the higher wind speed classes for all periods of the day. However, this effect is less pronounced during the 8 a.m. to 4 p.m. period.

Meteorological Associations

High ozone levels during the summer and fall generally occur on sunny days with light winds and high temperatures.

Widespread thunderstorm activity over the region is the primary meteorological cause of regionwide low ozone levels. Cold fronts during the summer and fall are conducive to higher than usual nighttime ozone levels.

Transport Considerations

Examination of surface and upper air trajectories for periods of high ozone concentrations shows that local urban sources are important contributors. In the three case studies where brief periods of high ozone concentrations were analyzed in detail, Baton Rouge was shown to have a significant influence. From the receptor geometry available and the limited number of case studies, no conclusions could be drawn about New Orleans as an urban contributor. Although there are noticeable exceptions, most trajectories for low ozone days trace back to the Gulf of Mexico while trajectories for high ozone days trace back to land sources. In general, an increase in ventilation results in a decrease in ozone levels.

Statistical Correlations

Solar insolation (pyranometer readings) was found to have the highest statistical correlations with ozone levels. The correlation between daytime averages of ozone and pyranometer was .39 which is significant above the 99 percent level. Other positive correlations were found with σ_θ and temperature. For all data, negative correlations were found between ozone and wind speeds and between ozone and dew point. Note that the negative correlations between ozone and wind speed change when time of day is introduced. See Tables 4-5 through 4-13. From known physical considerations dew point is not believed to be an influencing factor upon ozone concentrations. Statistically, the combination of dew point and temperature can be shown to act as a surrogate for the pyranometer variable.

Low Ozone Concentrations

While it is difficult to ascertain the causes of high ozone measurements, low ozone measurements in this study were generally associated with one or more of the following meteorological conditions:

1) Reverse air trajectories which end up in the Gulf of Mexico.

2) High ventilation (high mixing height and/or high wind speed).

3) Frontal passages.

4) Widespread thunderstorm activity.

6.0 RECOMMENDATIONS

With the air quality and meteorological data compiled in this study, further analysis is in order. Specifically, long range upper air trajectories should be analyzed in greater detail and in order to accomplish this, more detailed case studies should be attempted. A ventilation factor should be estimated and added to the data points in the statistical analysis since it is now believed that this is an important variable. Statistical correlations with stability class estimates should also be made although stability class is probably not as important as ventilation.

It is recommended that in future studies of this type upper air data be obtained along with the surface data. Mixing height measurements with an acoustic sounder, for example, would greatly enhance the data base used in this study. Also, upper air ozone measurements should be made as frequently as possible in order to pinpoint the occurrences of high ozone aloft being captured by a gradually rising mixing layer. These upper air data along with surface air quality and meteorological measurements should provide guidance to many of the key questions left unanswered in this study.

7.0 BIBLIOGRAPHY

1. Williamson, H. J., O. M. Friedrich, and J. D. Stuart. Analysis of Random Errors in Air Quality Measurements. EPA 906/9-77-005, U. S. Environmental Protection Agency, Dallas, Texas, June 1977, 65 pp.

2. Harper, David L. Relationship of Meteorology to Summer Ozone in Southern Louisiana. EPA 906/9-78-002B, U. S. Environmental Protection Agency, Dallas, Texas, September 1978, 45 pp.

3. Lambeth, B. W. Detailed Case Studies of Summer Ozone Events in Southern Louisiana. EPA 906/9-78-002D, U. S. Environmental Protection Agency, Dallas, Texas, September 1978, 145 pp.

4. Williamson, Hugh J. Statistical Analysis of Factors Influencing Ozone Concentrations in Southern Louisiana. EPA 906/9-78-002C, U. S. Environmental Protection Agency, Dallas, Texas, September 1978, 72 pp.

APPENDIX A
MONITORING SITE DESCRIPTIONS

MONITORING SITE #008
ST. GABRIEL

Radian ambient air monitoring system #008 was located at the LSU Agricultural Experimental Station on Louisiana Highway 30 in Iberville Parish, Louisiana. The site was 18 miles south of Baton Rouge. The site was at latitude 30° 16' 01" and longitude 91° 06' 02".

Monitoring site #008 was less than one mile east of the Mississippi River. Due to its location on the experimental station, the immediate surroundings were agricultural. The land surrounding the site was devoted both to crops and to pasture land for cattle. During the tenure of the monitoring system, the land adjacent to the trailer on the west and south was plowed and planted. This may have influenced particulate loadings. Other potential sources of emissions were power plants and chemical plants to the northwest and southwest. The St. Gabriel gas and oil field was located three to five miles to the east of the site.

The St. Gabriel system was deployed July 16, 1976 but power was not available until August 4, 1976. Official data collection began August 5, 1976 and continued until October 15, 1976.

Monitoring system #008 was a very good site meteorologically and met all EPA siting requirements.

MONITORING SITE #010
ST. ALMA

Radian ambient air monitoring system #010 was located in the grassy area at the rear of the St. Alma Elementary School in Pointe Coupee Parish, Louisiana. The St. Alma Elementary School is located on Louisiana Highway 413 approximately 3.64 miles north of Erwinville, Louisiana, and approximately 18 miles west of Baton Rouge. The site was at latitude 30°35'10" and longitude 91°23'50".

The monitoring system was deployed on July 7, 1976 and began taking official data on July 15, 1976. Data were collected until October 14, 1976.

Monitoring site #010 was located to the west of the large industrial complex loacted along the Mississippi River at Baton Rouge. This complex includes oil refineries, metals industries, and petrochemical complexes. These industries emit sulfur dioxide, carbon monoxide, nitrogen oxides, and various hydrocarbon compounds.

The monitoring site at St. Alma was located in an agricultural setting. Sugar cane fields surrounded the school and monitoring system on all four sides. During the course of the monitoring period the sugar cane fields were crop-dusted which may have affected some particulate data. Also during the course of the monitoring a drilling rig was set up across from the St. Alma School but no noticeable effects were observed as a result of the drilling. Louisiana Highway 413 passing in front of the St. Alma Elementary School is a medium-duty highway.

The site at St. Alma was meteorological good as there were no nearby obstructions to airflow and the terrain was flat. This system met all EPA siting requirements.

MONITORING SITE #012
NORCO

Radian ambient air monitoring system #012 was located on the Corps of Engineers grounds at Bonnet Carre Spillway in Norco, Louisiana. Norco in St. Charles Parish is located on the Mississippi River between Baton Rouge and New Orleans. The monitoring system at Norco was located atop the levee on the east bank of the Mississippi River. The system was 75 yards north of the river. Located atop the levee the site was elevated above its surroundings. The site was at latitude 30°00' and longitude 90°26'.

Siting monitoring station #012 along the Mississippi River placed it in the midst of one of the large industrial complexes located along the river. The industries around Norco include refineries, chemical plants, and power plants. These facilities are potential sources of sulfur dioxide, carbon monoxide, nitrogen oxides, and hydrocarbons. The heavy barge and shipping traffic along the river are also potential sources of emissions.

The only obstructions to air flows were several tall trees 50 yards southeast of the site. From its vantage point on the levee the monitoring system was accessible to air flow from all directions. The site was bounded by the Mississippi River, the Bonnet Carre Spillway, and the Shell Chemical plant. The monitoring station met all EPA siting requirements and was fair meteorologically.

Monitoring station #012 was deployed on July 14, 1976 and began taking official data on July 17, 1976. Data collection continued until October 22, 1976.

MONITORING SITE #013
GALLIANO

Radian ambient air monitoring site #013 was located at the South Lafourche High School between Galliano and Larose in Lafourche Parish, Louisiana. This location was in the south-eastern portion of Louisiana.

The monitoring trailer was sited on the east side of the baseball field at the rear of the high school and football stadium. East of the system was a drainage ditch and an open field. The land to the south was residential. To the west of the trailer were the baseball field, football stadium, and high school. Several houses were approximately 75 yards north of the trailer.

The South Lafourche High School is located on the east bank of the Lafourche Bayou. The bayou is paralleled by Louisiana Highway 1 on the west and Louisiana Highway 308 on the east. These are, respectively, heavy-duty and medium-duty roads. Growth in this area has been along the bayou combining residential and business locations. Most of the industry along the bayou is devoted to the barge traffic using the waterway. The land surrounding the monitoring site is very low and swampy with few trees. There are several oil and gas fields in this area of Louisiana.

Monitoring system #013 was deployed June 29 but power was not available until July 14, 1976. Official data collection began July 17, 1976 and continued until October 17, 1976. This site met EPA siting requirements and can be classified as good, considering meteorological requirements for siting.

MONITORING SITE #014
NASA

Radian ambient air monitoring system #014 was located at the NASA Michoud Facility on the eastern side of New Orleans in Orleans Parish, Louisiana. The site was at latitude 30°00'58" and longitude 89°54'35".

Trailer #014 was sited in the southeast corner of the NASA complex near the intersection of the Michoud Canal with the Intracoastal Waterway. Potential sources of emissions are the industries located along the surrounding waterways and the heavy shipping traffic that uses the Intracoastal Waterway and the Mississippi River Outlet Canal. The surrounding countryside is very low, but the monitoring system was located near some small buildings which presented some obstructions to uniform air flow.

The NASA monitoring system was deployed July 2, 1976 and began official data collection on July 17, 1976. Data collection continued until October 22, 1976. The system met EPA siting requirements.

The buildings and obstacles to the flow at this site decreased wind speeds slightly because of frictional effects and may have channelled the winds slightly for certain wind directions. Temperatures may have been increased slightly because of these nearby obstructions to the flow. From a meteorological point of view, this site was poor.

MONITORING SITE #016
MORGAN CITY

Radian ambient air monitoring system #016 was located at the Corps of Engineers facility at Bayou Boeuf Locks in Morgan City, Louisiana. Morgan City in St. Mary Parish is located on the Atchafalaya River near the Gulf of Mexico coast. The monitoring site was at 29°40'59" and longitude 91°19'21".

The monitoring site at Morgan City was on a projection into the Bayou Boeuf portion of the Intracoastal Waterway. The major potential sources of emissions are the barge and shipping traffic along the bayous and river and the land-based industry associated with off-shore technology. Gas and oil fields are present in the surrounding marsh land. The levee to the south offers the only obstruction to air flow but the site is otherwise good from a meteorological standpoint. West of the monitoring site were the headquarters and offices of the Corps of Engineers. North of the site was an inlet for docking ships.

Monitoring system #016 was deployed at Morgan City on July 14, 1976 and began taking official data on July 17, 1976. Data collection continued until October 15, 1976. This monitoring system met EPA siting requirements.

MONITORING SITE #017
ST. JAMES

Radian ambient air monitoring system #017 was located on the property of the Shell Oil Pipeline facility near St. James in St. James Parish, Louisiana. The site was approximately 2.5 miles north of St. James and approximately 8 miles southeast of Donaldsonville. The latitude was 30°01'03" and the longitude was 90°50'28".

Monitoring system #017 was sited approximately 30 feet east of Louisiana Highway 18 and approximately 40 yards west of the levee bordering the Mississippi River. South of the site was the pumping station. Near this portion of the river were refineries and petrochemical plants. The traffic on the river was heavy with loading facilities near the site. West of the site were oil and gas fields. The levee to the west, which was 20 to 30 feet high, was an obstruction to wind flow and may have channelled the winds occasionally.

The St. James site was deployed July 14, 1976 and began official data collection on July 17, 1976. Data collection continued until October 17, 1976. This location met EPA siting requirements. It was fair meteorologically.

MONITORING SITE #018
VINTON

Radian ambient air monitoring system #018 was located at the city sewage plant in Vinton, Calcasieu Parish, Louisiana. Vinton is located midway between Orange, Texas, and Sulfur, Louisiana. The site was at latitude 30°11'02" and longitude 93°34'35".

Located to the southwest of the Vinton site is the large refining and petrochemical complex at Orange, Texas. The same type of industry is also present at Lake Charles and Sulphur, Louisiana, which are east of Vinton. In addition, oil and gas fields are situated on all four sides of Vinton. These industries are potential sources of emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons.

The ambient air monitoring system at Vinton was approximately 35 yards west of the sewage treatment plant beside a very lightly traveled dirt road. The Vinton drainage canal was approximately 60 yards south of the site. Short trees and obstacles were located to the west, south, and east and may have affected wind speeds and wind directions by channelling the flow. The residential section of Vinton was two blocks away to the north and northeast.

Monitoring system #018 at Vinton was deployed June 29, 1976 and began taking official data July 17, 1976. Data collection continued until October 22, 1976. The Vinton system met EPA siting requirements. The site was poor meteorologically, because of the obstacles to the flow.

MONITORING SITE #019
LAFAYETTE

Radian ambient air monitoring system #019 was located at the Lafayette Regional Airport in Lafayette Parish, Louisiana. The site was located at latitude 30°12'14" and longitude 91°59'25".

The monitoring system was sited in an open area bounded on two sides by the airport. Directly across the street from the monitoring trailer in the east direction and at a distance of approximately 100 yards was an area in which two to three large prop planes were usually parked for refueling and repair. The main terminal was south of the site and separated from it by a parking lot and a line of buildings. Southwest of the monitoring site was a large, busy helioport. This helioport is the terminal for making connections with offshore drilling platforms. The air traffic at the Lafayette Regional Airport is heavy because of the offshore service. The monitoring site was less than one-half mile east of Highway 90, a heavy duty road. Much of the area near Lafayette is devoted to agriculture.

The Lafayette site was deployed July 13, 1976 and began taking official data on July 17, 1976. Data collection continued until October 16, 1976. Monitoring site #019 at Lafayette met EPA siting requirements. The site was good meteorologically with a mound of dirt 20 yards north being the only obstacle to the flow.

APPENDIX B

DEPENDENCE OF NO_x, NO, AND SO_2 CONCENTRATIONS ON WIND DIRECTION, TIME OF DAY, AND DAY OF WEEK

WIND DIRECTION DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITROGEN OXIDES

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	1	1	1	1	1	2	2	2	2	2	2	2	2	4	3	3	5	3
10	1	1	2	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2
12	7	3	6	10	9	20	6	8	5	6	5	4	7	5	5	6	13	7
13	2	1	2	2	1	1	2	2	2	2	2	2	3	3	3	3	3	2
14	3	7	2	2	1	2	2	2	3	5	7	9	17	4	2	2	11	3
16	5	4	2	3	2	2	2	2	2	2	3	3	3	2	2	2	5	3
17	7	5	4	7	5	7	9	8	9	11	7	5	10	14	13	11	26	9
18	1	1	1	2	4	2	2	2	3	4	2	2	2	2	1	1	7	4
19	1	1	1	1	1	1	1	1	3	3	3	3	4	4	3	2	8	2

HOUR OF DAY DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITROGEN OXIDES

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	3	3	3	4	2	3	3	3	4	3	3	2	2	2	1	2	2	2	2	3	3	3	3	4	3
10	2	2	2	2	2	2	2	3	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2
12	10	11	10	8	7	8	12	14	13	7	5	4	4	4	4	5	5	6	5	6	7	8	8	10	7
13	3	3	3	3	3	3	3	3	2	2	2	1	1	1	1	1	1	1	2	2	2	2	3	3	2
14	5	6	8	10	7	6	7	10	5	2	2	2	2	2	1	1	2	2	2	2	3	4	6	7	3
15	3	4	4	3	4	5	5	7	6	3	2	1	1	2	2	2	2	2	2	3	3	3	4	4	3
17	7	7	6	8	9	13	21	25	15	11	6	5	5	4	5	6	7	6	11	10	12	14	12	9	9
18	5	5	4	4	3	3	4	5	5	3	2	1	1	1	1	1	2	2	4	8	9	10	8	8	4
19	3	2	2	2	2	2	4	5	4	2	1	1	1	1	1	1	1	1	1	2	3	3	3	3	2
TOTAL	4	4	4	4	4	4	5	6	5	3	2	2	2	2	2	2	2	2	2	3	4	4	5	5	3

DAY OF WEEK DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITROGEN OXIDES

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
9	2	2	2	3	3	3	3	3
10	2	2	1	2	1	2	2	2
12	8	6	6	8	8	7	7	7
13	2	2	2	2	2	2	3	2
14	3	4	3	3	4	5	4	3
15	2	2	3	3	3	3	2	3
17	6	7	8	12	12	10	7	9
18	4	4	3	3	4	5	3	4
19	2	2	2	2	2	2	2	2
TOTAL	3	3	3	3	3	4	3	3

WIND DIRECTION DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITRIC OXIDE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	3	2	3	4	3	4	2	2	2	2	2	2	2	2	2	3	4	2
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
14	1	2	1	1	1	1	1	1	1	1	1	2	4	2	1	1	3	2
16	2	1	1	2	2	2	1	2	1	2	2	2	1	2	1	1	3	2
17	2	2	2	2	2	2	3	2	3	4	3	3	4	4	3	5	12	3
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
19	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	1	4	1

HOUR OF DAY DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITRIC OXIDE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
9	2	1	2	2	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	2	3	3	2	2	3	4	5	4	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13	2	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	2	2	2	2	2	2	3	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
15	2	2	2	2	2	2	3	3	3	2	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
17	2	2	2	2	4	6	10	12	6	3	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
18	2	2	2	2	2	2	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
19	1	1	1	1	1	1	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL	2	2	2	2	2	2	2	3	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2

DAY OF WEEK DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF NITRIC OXIDE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1
12	2	2	2	3	2	3	3	2
13	1	1	1	1	1	1	2	1
14	2	1	1	2	2	2	2	2
16	2	2	2	2	2	2	1	2
17	2	2	2	3	4	5	3	3
18	2	2	1	1	1	2	2	2
19	1	1	1	1	1	2	1	1
TOTAL	2	1	1	2	2	2	2	2

WIND DIRECTION DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF SULFUR DIOXIDE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	2	1	1	2	2	2	1	1	1	1	2	6	2	1	1	1	1	1
13	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	6	19	6	5	2	2	3	12	5	1	1	1	1	2	3	1	1	2
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

HOUR OF DAY DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF SULFUR DIOXIDE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	2	2	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1	2	1	2	2	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	2	1	1	1	1	1	1	1	2	3	7	13	8	11	7	5	4	3	2	2	2	2	2	2	2
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

DAY OF WEEK DEPENDENCE

GEOMETRIC MEAN CONCENTRATIONS (PPB) OF SULFUR DIOXIDE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1
12	2	1	1	1	1	2	2	1
13	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1
17	1	2	4	2	4	3	2	2
18	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1
TOTAL	1	1	1	1	1	1	1	1

APPENDIX C
NUMBER OF OBSERVATIONS FOR POLLUTANT GEOMETRIC MEAN TABLES

WIND DIRECTION DEPENDENCE

NUMBER OF OBSERVATIONS OF OZONE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	10	52	73	111	97	85	49	57	55	58	88	93	71	51	62	32	441	1485
10	15	35	90	124	123	81	96	80	71	68	80	76	97	84	91	56	384	1651
12	14	38	65	70	55	86	42	37	61	57	40	58	71	53	54	42	119	962
13	2	27	57	59	90	42	31	22	31	17	25	11	7	14	24	17	102	578
14	7	59	109	53	91	98	89	60	64	66	51	71	101	85	60	35	152	1251
16	29	105	127	81	114	47	80	75	104	75	88	59	61	63	87	78	481	1754
17	16	24	68	77	67	77	48	38	33	51	57	48	38	36	47	45	97	867
18	15	36	34	33	33	34	60	58	71	70	32	22	25	32	38	52	565	1211
19	23	123	179	176	142	135	126	115	134	113	123	99	102	122	99	53	140	2004

HOUR OF DAY DEPENDENCE

NUMBER OF OBSERVATIONS OF OZONE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	64	65	65	22	65	65	65	64	64	63	63	63	64	64	64	64	62	61	63	63	63	63	63	63	1485
10	71	71	73	53	70	70	70	70	69	68	65	64	65	64	65	70	70	71	71	73	72	73	74	72	1651
12	42	42	43	16	41	41	41	41	40	40	41	40	39	40	39	39	39	40	41	43	43	43	44	44	962
13	37	37	36	11	36	36	35	35	35	36	35	36	35	33	33	35	37	38	38	38	38	38	39	39	847
14	54	54	54	28	54	54	54	54	54	54	54	53	52	53	53	52	51	51	52	53	53	53	53	54	1251
15	82	81	81	59	80	80	80	80	80	80	77	75	77	80	77	77	79	80	80	80	81	81	81	81	1889
17	37	37	37	16	37	37	37	36	37	37	37	37	36	35	35	39	38	39	36	36	38	38	37	38	867
18	52	52	52	47	51	51	51	51	51	50	51	51	51	49	48	46	48	49	51	51	52	52	52	52	1211
19	87	87	86	35	87	86	87	86	87	87	86	84	84	85	83	82	85	85	84	86	85	86	86	86	2004
TOTAL	526	526	524	287	521	522	523	517	517	515	510	503	503	503	497	504	509	514	516	523	525	527	529	529	12167

DAY OF WEEK DEPENDENCE

NUMBER OF OBSERVATIONS OF OZONE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	210	202	201	194	226	227	225	1485
10	273	261	235	215	196	241	229	1651
12	144	115	117	116	138	175	165	962
13	139	114	115	126	124	116	113	847
14	181	152	143	157	213	203	202	1251
16	375	282	284	241	249	247	281	1889
17	126	116	119	131	115	131	129	867
18	167	141	168	188	188	178	189	1211
19	333	294	279	278	279	259	302	2004
TOTAL	1848	1577	1662	1646	1728	1779	1835	12167

WIND DIRECTION DEPENDENCE

NUMBER OF OBSERVATIONS OF NITROGEN OXIDES

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	13	59	65	98	91	86	55	60	60	60	91	100	84	67	83	47	454	1573
12	16	36	96	133	141	91	113	99	94	87	106	94	112	102	108	58	443	1929
12	22	73	121	135	102	125	63	78	106	96	80	82	118	90	100	104	180	1665
13	4	48	94	112	139	96	90	67	86	84	85	51	62	47	44	29	357	1497
14	23	83	138	77	115	114	111	81	92	81	56	77	114	115	91	69	161	1598
16	17	67	64	31	47	22	48	45	59	66	86	48	42	51	60	45	290	1088
17	27	55	112	96	104	114	74	60	68	92	74	79	53	75	68	68	130	1349
18	19	47	56	50	35	46	72	67	105	101	39	42	35	40	47	65	725	1591
19	18	112	154	134	105	105	98	96	103	99	97	78	83	98	75	36	91	1582

HOUR OF DAY DEPENDENCE

NUMBER OF OBSERVATIONS OF NITROGEN OXIDES

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	68	68	69	27	69	69	69	69	69	69	67	67	66	64	65	67	65	65	65	67	67	68	67	67	1573
10	83	83	82	64	82	82	82	82	81	80	78	78	76	75	79	80	80	82	82	84	83	83	85	83	1929
12	77	77	77	41	78	79	78	78	77	77	74	72	74	74	74	76	75	77	77	77	77	77	77	78	1798
13	68	68	67	33	66	65	65	66	65	67	66	65	64	65	65	64	67	67	67	69	69	69	69	67	1563
14	68	68	68	38	69	69	69	69	69	68	68	66	68	65	66	66	67	68	69	69	69	68	67	67	1598
16	51	50	51	33	51	51	51	51	51	49	47	47	49	49	49	49	50	50	49	49	49	49	49	49	1173
17	57	57	57	41	54	53	53	52	53	54	55	54	58	59	62	61	61	62	57	57	58	58	58	58	1349
18	67	67	67	61	67	66	66	66	66	64	64	64	64	66	65	67	65	64	67	67	66	69	66	66	1591
19	70	70	70	19	69	69	69	68	69	67	66	65	65	66	65	66	66	67	69	69	69	70	69	70	1582
TOTAL	609	608	608	357	605	605	604	603	602	595	585	578	584	583	590	596	596	602	602	608	609	611	609	607	14156

DAY OF WEEK DEPENDENCE

NUMBER OF OBSERVATIONS OF NITROGEN OXIDES

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	234	214	202	212	244	239	228	1573
10	307	303	282	259	237	252	279	1929
12	253	248	260	273	242	244	278	1798
13	238	217	203	192	232	237	244	1563
14	215	238	207	237	243	225	233	1598
16	179	165	154	161	153	170	181	1173
17	185	219	232	207	204	173	159	1349
18	213	192	231	224	234	238	259	1591
19	246	245	225	229	214	193	229	1582
TOTAL	2070	2041	1967	1994	2013	1981	2090	14156

WIND DIRECTION DEPENDENCE

NUMBER OF OBSERVATIONS OF NITRIC OXIDE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	13	58	69	103	97	84	54	57	52	57	89	100	85	67	83	47	435	1550
10	15	36	95	132	134	83	111	93	91	84	98	89	110	99	104	58	425	1858
12	21	73	115	121	99	124	60	70	100	104	91	92	136	108	117	132	168	1731
13	4	35	85	103	121	91	89	66	83	86	83	50	66	80	64	34	341	1461
14	23	83	139	77	119	128	114	85	96	86	61	86	129	120	99	72	174	1691
16	17	67	85	31	49	23	49	45	60	65	87	48	42	51	60	45	298	1102
17	27	55	114	96	104	116	74	63	68	92	76	83	57	78	69	71	132	1375
18	19	47	55	49	35	44	66	66	135	101	39	42	35	40	47	65	723	1580
19	17	114	153	143	109	101	104	95	107	99	100	80	80	98	75	38	102	1615

HOUR OF DAY DEPENDENCE

NUMBER OF OBSERVATIONS OF NITRIC OXIDE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
8	67	67	68	25	68	68	66	68	66	68	65	65	66	64	64	66	64	64	65	66	66	67	66	66	1559
10	82	80	79	61	79	79	79	79	78	77	75	75	73	73	76	77	77	79	79	81	80	80	82	80	1858
12	82	80	80	46	78	79	78	79	78	76	75	75	77	76	76	79	79	81	80	82	83	82	79	81	1861
13	66	66	65	33	62	62	62	64	63	65	64	63	62	64	63	63	65	65	64	65	66	66	66	64	1507
14	73	73	73	40	73	73	73	73	73	72	72	72	72	69	70	70	71	72	72	72	73	70	71	71	1691
15	51	50	51	37	52	52	52	52	52	50	48	47	49	50	49	49	50	50	50	50	50	49	49	49	1186
17	58	58	58	45	55	54	54	53	54	55	56	55	58	60	63	62	62	63	58	58	59	59	59	59	1375
18	67	67	67	52	66	67	67	67	67	63	63	63	63	65	64	66	65	64	67	67	68	69	68	68	1580
19	71	71	70	23	71	71	71	72	71	69	68	66	66	67	66	67	66	69	70	70	70	71	70	71	1615
TOTAL	613	612	611	372	604	605	604	605	604	595	587	579	586	598	591	599	599	607	605	611	615	613	610	609	14225

DAY OF WEEK DEPENDENCE

NUMBER OF OBSERVATIONS OF NITRIC OXIDE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	231	233	225	215	225	217	204	1550
10	303	303	282	259	216	238	255	1858
12	262	222	242	258	259	295	303	1861
13	229	212	203	213	237	188	225	1507
14	258	245	244	243	243	225	233	1691
15	178	156	156	162	171	171	184	1188
17	185	229	202	207	225	193	163	1375
18	213	192	219	224	234	239	259	1580
19	243	245	227	229	215	241	214	1615
TOTAL	2102	2038	2000	2020	2018	2007	2040	14225

WIND DIRECTION DEPENDENCE

NUMBER OF OBSERVATIONS OF SULFUR DIOXIDE

SITE	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
8	14	52	45	84	85	74	51	48	53	47	63	75	54	53	54	40	394	1286
10	14	34	88	113	138	85	134	88	86	75	87	85	102	83	98	46	384	1708
12	19	59	99	112	86	121	56	63	85	77	65	82	112	86	113	131	172	1538
13	4	45	83	130	105	75	83	62	78	75	77	49	52	48	50	27	340	1354
14	22	78	129	74	107	119	107	90	95	86	57	81	126	115	96	70	179	1634
15	18	73	76	43	55	30	55	55	77	79	94	56	52	64	65	56	335	1284
17	8	5	17	21	23	29	25	13	12	18	14	12	10	19	34	36	34	330
18	10	22	15	20	22	23	47	42	55	55	20	12	16	21	31	46	417	872
19	19	119	156	153	124	116	108	99	110	98	95	72	69	87	79	37	97	1639

HOUR OF DAY DEPENDENCE

NUMBER OF OBSERVATIONS OF SULFUR DIOXIDE

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
5	57	57	57	30	55	55	55	55	54	53	53	54	55	54	56	56	55	51	51	54	54	55	55	55	1286
10	74	74	73	56	71	71	71	71	70	69	67	66	70	71	69	71	74	74	73	74	74	74	75	74	1708
12	64	64	64	48	66	66	66	66	66	66	64	65	64	65	63	65	63	63	65	65	65	65	65	65	1538
13	61	61	60	32	60	60	60	60	60	61	61	58	58	59	59	58	60	62	62	62	62	64	64	63	1427
14	70	70	70	36	71	71	71	71	71	71	71	67	69	68	68	69	67	68	69	69	70	69	69	69	1634
16	62	61	62	55	61	61	60	61	61	60	56	58	58	57	58	58	59	58	58	58	59	59	59	59	1418
17	14	14	14	14	14	14	14	13	14	13	12	12	13	14	14	13	13	13	14	14	15	15	15	15	330
18	38	38	38	38	37	37	37	37	37	36	35	36	35	35	34	35	34	35	34	35	36	38	38	39	872
19	72	72	71	36	70	70	70	69	70	70	69	68	68	67	68	67	70	69	70	70	70	71	71	71	1639
TOTAL	512	511	509	345	505	505	504	503	503	499	488	486	490	490	489	492	495	493	496	501	505	510	511	510	11852

DAY OF WEEK DEPENDENCE

NUMBER OF OBSERVATIONS OF SULFUR DIOXIDE

SITE	SUN	MON	TUE	WED	THU	FRI	SAT	TOTAL
8	168	149	189	162	204	219	204	1286
10	273	297	242	242	228	222	204	1708
12	237	208	230	195	208	231	237	1538
13	206	205	200	177	237	197	205	1427
14	240	218	224	219	241	243	249	1834
15	217	209	188	224	192	192	216	1418
17	51	48	48	43	45	48	47	330
18	120	123	137	124	105	118	144	872
19	258	254	238	232	252	188	217	1639
TOTAL	1770	1703	1696	1598	1713	1649	1723	11852

OZONE NO. OF OBSERVATIONS - SITE 8

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	3	33	41	50	52	32	34	22	18	22	17	21	13	18	24	12	412
3-6	2	11	7	7	4	3	1	1	1	3	3	4	6	2	4	1	60
GE 7									1			1	1				3
ALL	5	44	48	57	56	35	35	23	20	25	20	26	20	20	28	13	475

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		6	13	17	22	19	12	12	17	5	10	7	6	9		2	157
3-6	1	7	25	37	19	16	8	14	18	11	25	31	25	13	17	7	276
GE 7	2	4	3	16	11	7	2	2		2	4	2	2	4	11	4	76
ALL	3	17	41	70	52	42	22	28	35	18	40	40	34	26	28	13	509

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	6	10	20	21	22	31	25	17	21	20	25	27	15	15	5	281
3-6	1	4	4	11	10	22	11	14	14	18	19	21	8	6	12	4	179
GE 7	2	4	1		9	7		1		1	3	2	1	2	4	4	41
ALL	4	14	15	31	40	51	42	40	31	40	42	48	36	23	31	13	501

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	4	45	64	87	95	73	77	59	52	48	47	53	46	42	39	19	850
3-6	4	22	35	55	33	41	20	29	33	32	48	56	40	21	33	12	515
GE 7	4	8	4	16	20	14	2	3	1	3	7	5	4	6	15	8	120
ALL	12	75	104	158	148	128	99	91	86	83	102	114	90	69	87	39	1485

OZONE NO. OF OBSERVATIONS - SITE 10

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		24	85	101	73	45	34	12	15	17	11	10	12	10	3	3	457
3-6	6	10	5	9	2	1	1	3	5		2	8	6	1	7	11	78
GE 7	2	1	1	1												5	10
ALL	8	35	93	111	75	47	35	15	20	17	13	18	18	11	10	19	545

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	1	12	25	15	13	18	12	6	15	9	7	7	3	1		145
3-6		3	25	46	38	15	19	15	15	10	13	16	33	37	27	5	319
GE 7	2			8	11	3	2	4	1		5	1	2	5	19	3	66
ALL	3	4	37	79	64	32	39	32	22	25	27	24	42	45	47	8	530

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		2	32	35	45	41	34	29	22	20	26	19	14	10	11	2	342
3-6	3	7	5	11	18	7	6	12	15	10	14	15	23	18	15	23	204
GE 7	1			1	6	3	1	2	2			2			8	4	30
ALL	4	9	38	47	69	51	41	43	39	30	40	37	37	28	34	29	576

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	27	130	161	133	100	86	53	43	52	46	36	33	23	15	5	944
3-6	9	20	37	66	58	24	26	31	35	20	29	40	62	56	49	39	601
GE 7	5	1	1	10	17	6	3	6	3		5	3	2	5	27	12	106
ALL	15	48	168	237	208	130	115	90	81	72	80	79	97	84	91	56	1651

OZONE NO. OF OBSERVATIONS - SITE 12

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		1	2	3	11	15	13	8	16	17	14	9	27	21	15	8	181
3-6	1	8	8	7	12	4	1	1	5	2	3	7	16	5	3	4	87
GE 7	4		5	14	3	1					1	3			1	6	39
ALL	5	9	15	24	26	21	14	9	21	19	18	19	43	26	19	18	307

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			2	3	2	7	5	13	6	7	7	8	6	9	5	4	84
3-6		5	14	14	8	11	9	2	8	7	3	8	8	9	12	9	127
GE 7	2	17	29	19	7	5		1			2	4	6	3	3	8	107
ALL	2	22	45	36	17	24	14	15	14	14	12	20	20	21	20	21	318

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		1	1	3	10	33	25	22	13	18	11	5	3	2	4		151
3-6	2	3	3	9	7	12	4	3	26	14	7	12	11	7	10	2	131
GE 7	5	4	4	4	5	12	2	1	1	5	1	5	2		3	2	55
ALL	7	8	8	15	22	55	31	26	40	37	19	23	15	9	17	4	337

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		2	5	9	23	55	43	43	35	42	32	22	36	32	24	12	416
3-6	3	16	25	29	27	27	14	6	39	23	13	27	35	21	25	15	345
GE 7	11	21	39	37	15	17	2	2	1	5	4	13	8	3	7	16	201
ALL	14	39	69	75	65	100	59	51	75	70	49	62	79	56	56	43	962

OZONE NO. OF OBSERVATIONS - SITE 13

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		4	14	25	25	6	12	8	9	3	7	1	2	4	2	2	126
3-6	1	14	8		4	1			1	1	1		2	1	8	6	48
GE 7		1			4												5
ALL	1	19	22	25	33	9	12	8	10	4	8	1	4	5	10	8	179

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			9	5	6	5	2	1	1			1					30
3-6		4	10	14	27	9	3	1	5	3	5	1	1	3	4	7	97
GE 7			7	8	19	5	1	1	2	2	5	5	2		3	2	63
ALL		4	25	27	52	20	6	3	8	5	10	7	3	3	7	9	190

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		2	7	16	24	14	19	8	5	2	1	1		1	3		103
3-6	1	2	5	9	8	12	4	4	8	4	6	1		2	3		70
GE 7			1	7	15	2	2	1	1	2		1		3	1		36
ALL	1	4	14	32	47	28	25	13	14	8	7	3		6	7		209

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		6	30	46	55	27	33	17	15	5	8	3	2	5	5	2	259
3-6	2	20	24	23	39	22	7	5	14	8	12	2	3	6	15	13	215
GE 7		1	8	15	38	8	3	2	3	4	5	6	2	3	4	2	104
ALL	2	27	62	84	132	57	43	24	32	17	25	11	7	14	24	17	578

OZONE NO. OF OBSERVATIONS - SITE 14

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		5	20	9	6	7	5	11	17	22	16	30	74	32	12	5	271
3-6	1	16	28	4	4	3	4	4	1	2	1	5	12	5	8	5	103
GE 7	1	16	3		4	5						2	1				32
ALL	2	37	51	13	14	15	9	15	18	24	17	37	87	37	20	10	406

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		5	8	9	15	13	18	9	6	4	2	5	5	4	4	2	110
3-6	1	9	17	11	20	42	18	3	7	3	5	9	13	23	21	10	212
GE 7	1	4	8	12	24	7	4	1	2	1	3	1	3	12	13	7	103
ALL	2	18	33	32	59	62	40	13	15	8	10	16	21	39	38	19	425

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			6	5	3	5	18	21	22	29	14	23	16	5	5	2	174
3-6	1	5	24	5	12	13	21	17	22	19	14	7	10	16	2	5	193
GE 7	2	1	1	5	8	7	10	5	2	3	2	4		1	2		53
ALL	3	6	31	15	23	25	49	43	46	51	30	34	26	22	9	7	420

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		10	34	23	24	25	41	41	45	55	32	59	95	41	21	9	555
3-6	3	30	69	20	36	58	43	24	30	24	20	21	35	44	31	20	508
GE 7	4	21	12	17	36	19	14	6	4	4	5	7	4	13	15	7	188
ALL	7	61	115	60	96	102	98	71	79	83	57	87	134	98	67	36	1251

OZONE NO. OF OBSERVATIONS - SITE 16

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	46	55	41	51	36	35	11	26	24	19	23	26	14	30	14	454
3-6	11	26	7	10	11	4	1	2	3	2	1	2	3	9	4	9	105
GE 7	3	4			3	1										5	16
ALL	15	76	63	51	65	41	37	13	29	26	20	25	29	23	34	28	575

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		5	22	16	19	14	13	10	14	11	6	11	8	7	5	1	162
3-6	3	25	56	26	25	6	15	25	48	15	14	15	18	21	20	13	349
GE 7	3	1	2	4	6	3	4	5	1	5	4	2	1	1	14	8	65
ALL	6	32	80	46	50	23	32	42	63	32	24	29	27	29	39	22	576

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		4	10	12	33	23	51	30	31	39	33	19	18	11	15	4	333
3-6	5	15	12	10	22	8	10	11	14	15	34	12	8	10	11	20	217
GE 7	4	4	2	2	5	4	2	1	2	2	8	4	1	2	4	6	53
ALL	9	23	24	24	60	35	63	42	47	56	75	35	27	23	30	30	603

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	55	88	69	103	73	100	51	71	74	58	53	52	32	50	19	949
3-6	19	67	75	45	58	18	26	39	65	33	49	30	29	40	35	42	671
GE 7	10	9	4	6	14	8	5	7	3	7	12	6	2	3	18	19	134
ALL	30	131	167	121	175	99	132	97	139	114	119	89	83	75	103	80	1754

OZONE NO. OF OBSERVATIONS - SITE 17

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		7	5	5	7	8	9	7	4	17	29	25	27	11	10	7	179
3-6	4	10	5	6	7	3	4	1	1	4	5	4	5	4	11	6	80
GE 7	1				3										3	8	15
ALL	5	17	11	11	17	11	13	8	5	21	34	29	32	15	24	21	274

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		3	14	19	12	22	8	5	2		2	1	3	3	1	1	96
3-6	1	5	27	21	13	17	8	10	4	4	4	3	3	6	7	5	138
GE 7		1	7	7	7	2		6		2		2	2	2	10	11	59
ALL	1	9	48	47	32	41	16	21	6	6	6	6	8	11	18	17	293

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			1	1	3	9	15	5	18	17	12	17	11	8	3		120
3-6	1	2	5	14	11	13	8	8	9	15	16	10	7	6	2	6	133
GE 7	9		3	5	6	7	1	1	1		1	1		1	5	6	47
ALL	10	2	9	20	20	29	24	14	28	32	29	28	18	15	10	12	300

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2		10	21	25	22	39	32	17	24	34	43	43	41	22	14	8	395
3-6	5	17	37	41	31	33	20	19	14	23	25	17	15	16	20	17	351
GE 7	10	1	10	12	16	9	1	7	1	2	1	3	2	3	18	25	121
ALL	15	28	68	78	69	81	53	43	39	59	69	63	58	41	52	50	867

OZONE NO. OF OBSERVATIONS - SITE 18

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	7	22	29	22	17	15	27	16	39	27	30	19	20	13	23	35	361
3-6	4	1	2	1	2	1	3	1	1	3	3	4	1	1	7	10	45
GE 7														1			1
ALL	11	23	31	23	19	16	30	17	40	30	33	23	21	15	30	45	407

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	3	7	20	18	16	23	32	33	20	14	12	13	13	4	4	233
3-6	1	8	11	5	8	12	18	18	9	10	8	4	8	9	9	10	148
GE 7	1	6	1			1		1		1					3	2	16
ALL	3	17	19	25	26	29	41	51	42	31	22	16	21	22	16	16	397

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	3	7	12	6	13	6	29	45	46	52	24	15	17	14	6	12	308
3-6	3	4	4	1	2	4	7	8	20	17	3	2	2	1	9	8	95
GE 7	1								1					1	1		4
ALL	7	11	15	7	15	10	36	53	67	69	27	18	19	16	16	20	407

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	11	32	48	48	48	37	79	93	118	99	68	47	50	40	33	51	992
3-6	8	13	17	7	12	17	28	27	30	30	14	10	11	11	25	28	288
GE 7	2	6	1			1		1	1	1				2	4	2	21
ALL	21	51	66	55	60	55	107	121	149	130	82	57	61	53	62	81	1211

OZONE NO. OF OBSERVATIONS - SITE 19

HOURS 0000 TO 0800

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	1	10	49	56	33	42	31	28	34	28	27	28	25	22	21	4	431
3-6	2	45	15	16	5	4	1	4	3	6	12	14	18	23	15	14	198
GE 7	1	2			1							1	3		3	3	14
ALL	4	57	65	72	39	46	32	32	37	34	39	35	46	45	39	21	643

HOURS 0800 TO 1600

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2			11	13	16	11	8	11	10	4	3	5	3	5	3	1	104
3-6		19	54	55	33	39	42	29	22	15	24	23	23	37	27	8	451
GE 7	1	9	14	16	12	6	11	2	7	2	5	2	7	11	12	6	123
ALL	1	28	79	84	61	56	61	42	39	22	32	30	33	53	42	15	678

HOURS 1600 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	3	18	10	12	18	24	38	20	24	22	22	9	5	12	5	4	246
3-6	13	17	27	15	26	24	17	24	37	40	34	26	23	14	10	7	354
GE 7	2	4	6	4	5	1	3	13	8	7	8	4	3	5	4	6	83
ALL	18	39	43	31	49	49	58	57	69	69	64	39	31	31	19	17	683

HOURS 0000 TO 2400

WS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0-2	4	28	70	81	67	77	77	59	68	54	52	34	33	39	29	9	781
3-6	15	81	97	86	64	67	60	57	62	62	70	63	64	74	52	29	1003
GE 7	4	15	20	20	18	7	14	15	15	9	13	7	13	16	19	15	220
ALL	23	124	187	187	149	151	151	131	145	125	135	104	110	129	100	53	2004